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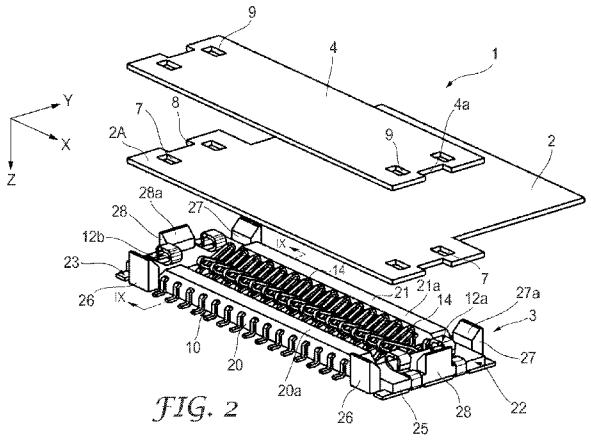


FIG. 2

(57) **Abstract**: A circuit assembly 1 has a wiring substrate 2 and an electrical connector 3, the electrical connector 3 including: a housing 10 having at least a first sidewall portion 20 and a second sidewall portion 21 arranged so as to oppose each other and an open surface OS that is demarcated by the first sidewall portion 20 and the second sidewall portion 21; a plurality of connection elements 14 arranged in rows in predetermined positions between the first sidewall portion 20 and the second sidewall portion 21, while being held by the first sidewall portion 20 and the second sidewall portion 21, and having a central portion 45 projecting from the open surface OS and inclined outward; and substrate holding portions 12a and 12b provided in correspondence with engagement holes 7 of PFC2. When the electrical connector 3 is coupled to the wiring substrate 2, the substrate holding portions 12 engage with the engagement holes of the PFC2.

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# CIRCUIT ASSEMBLY, METHOD OF ASSEMBLING CIRCUIT ASSEMBLY, AND ELECTRICAL CONNECTOR

## Technical Field

The present invention relates to a circuit assembly, an assembly method for a circuit assembly, and an electrical connector.

## Background Technology

There are various substrate circuit assemblies configured from a substrate connector having a plurality of connection elements for connecting between substrates. Well-known examples include the substrate connector below and a circuit assembly including the same, disclosed Patent Document 1.

Patent Document 1 describes "A circuit connecting configuration 1 including a printed wiring board 2 that is an insulating substrate with signal lines and ground lines formed on at least one major surface, and a substrate connector 15 used to electrically connect the printed wiring board 2 with an FPC 10, wherein a plurality of pairs of signal lines, which are electrically connected to substrate-side electrical connection parts of signal connection elements housed within the substrate connector 15, is positioned forward of the substrate connector 15 that is fixed to a major surface of the printed wiring board 2, a ground wire, which is electrically connected to the substrate-side electrical connection part of a ground connection element housed within the substrate connector 15, is positioned rearward of the substrate connector 15, and the signal lines and ground lines oppose each other".

[Background Documents]

[Patent Documents]

[Patent document 1]

Japanese Unexamined Patent Application Publication No. 2007-213998

## SUMMARY

[Problems to be Solved by the Invention]

In recent years, in the manufacturing process of electronic products there has been marked progress in the automation of mounting of electronic components and members (wiring substrates and the like) on circuit boards. However, in a circuit assembly of the type described in the above-mentioned Patent Document 1, the installation of the wiring substrate on a circuit board is performed via substrate connectors mounted on the circuit board. Here, to install the wiring substrate, it is necessary to insert through substrate connector insertion holes arranged in a plane substantially perpendicular to the circuit board. It is therefore, extremely difficult to automate the mounting of the wiring substrate on the circuit board.

Moreover, with the circuit assembly of the type described in Patent Document 1, when a ZIF (Zero Insertion Force socket) connector having a zero insertion force feature is used for attachment of the wiring substrate to the substrate connector, an operation will be required to insert the wiring substrate into the connector body, which has a slider or the like as a ZIF lock. For this reason, the mounting of the wiring substrate on the circuit board is extremely difficult to automate.

An object of the present invention is to provide a circuit assembly that enables automation of mounting of a wiring substrate on a circuit board, an assembly method for the circuit assembly, and an electrical connector.

[Means for Solving the Problem]

One aspect of the present invention is a circuit assembly including: a wiring substrate having fixture receiving means at both end portions; and an electrical connector including a housing that has electrical insulation properties and an open surface, a plurality of

conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with the fixture receiving means of the wiring substrate, wherein the fixture means engage with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are coupled.

In a first embodiment, when engaged with the fixture receiving means, the fixture means apply opposing forces to the wiring substrate, with the forces directed in a lateral direction away from the center of the wiring substrate.

In an embodiment, a pressing member is provided arranged over the wiring substrate, and this pressing member is fixed to the housing and presses the wiring substrate toward the housing side.

In an embodiment, the housing includes at least a first sidewall portion and a second sidewall portion arranged so as to oppose each other, with the open surface being demarcated by this first sidewall portion and this second sidewall portion, and the connection elements are arranged in a predetermined position between the first sidewall portion and the second sidewall portion, while being held by one or both of the first sidewall portion and the second sidewall portion.

Another aspect of the present invention is an assembly method for a circuit assembly including a wiring substrate and an electrical connector, the wiring substrate having fixture receiving means at both end portions, the electrical connector including a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held by the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with the fixture receiving means of the wiring substrate, the method

including a step of mounting the housing of the electrical connector on the wiring substrate and engaging the fixture means with the fixture receiving means of the wiring substrate.

A further aspect of the invention is an electrical connector for coupling with a wiring substrate, the electrical connector including: a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with fixture receiving means of the wiring substrate, wherein the fixture means engage with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are.

[Effect of the Invention]

According to the invention, the circuit assembly configured from the wiring substrate and the electrical connector allows the wiring substrate to be arranged over the electrical connector and fixed to the electrical connector, and it is therefore possible to automate the mounting of the wiring substrate.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a circuit assembly according to a first embodiment.

FIG. 2 is an exploded perspective view of the circuit assembly illustrated in FIG. 1.

FIG. 3A is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 1 from above; FIG. 3B is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 1 from below.

FIG. 4 is an exploded perspective view of the electrical connector of the circuit assembly illustrated in FIG. 1.

FIG. 5 is an enlarged partial perspective view illustrating the electrical connector.

FIG. 6A is a side view illustrating a state prior to coupling the wiring substrate and the electrical connector.

FIG. 6B is a side view illustrating a state after coupling the wiring substrate and the electrical connector.

FIG. 7A is an enlarged partial sectional view illustrating a state prior to coupling the wiring substrate and the electrical connector.

FIG. 7B is an enlarged partial sectional view illustrating a state after coupling the wiring substrate and the electrical connector.

FIG. 8 is a perspective view of a connection element.

FIG. 9 is a sectional view through IX-IX in FIG. 2.

FIG. 10 is a view illustrating an assembly process for the circuit assembly.

FIG. 11 is a perspective view illustrating another mode of the first embodiment.

FIG. 12 is a perspective view of a circuit assembly according to a second embodiment.

FIG. 13A is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 12 from above.

FIG. 13B is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 12 from below.

FIG. 14A is a perspective view illustrating the electrical connector of circuit assembly shown in FIG. 12 from above.

FIG 14B is a perspective view illustrating the electrical connector of the circuit assembly shown in FIG. 12 from above.

FIG. 15 is a perspective view illustrating a state after coupling of the electrical connector and the wiring substrate.

FIG. 16A is a perspective view illustrating a pressing member of the circuit assembly shown in FIG. 12 from above.

FIG. 16B is a perspective view illustrating the pressing member of the circuit assembly shown in FIG. 12 from below.

FIG. 17 is a perspective view of an electrical connector of a circuit assembly according to a third embodiment.

FIG. 18 is a sectional view through A-A in FIG. 17.

FIG. 19 is a perspective view of an electrical connector of a circuit assembly according to a fourth embodiment.

FIG. 20 is a sectional view through B-B in FIG. 19.

## DETAILED DESCRIPTION

Preferred embodiments according to the present invention will be explained in detail below, referencing the appended drawings. Note that in the description of the drawings identical or corresponding elements are designated using the same symbols and overlapping descriptions will be omitted.

[First Embodiment]

FIG. 1 is a perspective view of a circuit assembly according to a first embodiment. FIG. 2 is an exploded perspective view of the circuit assembly illustrated in FIG. 1. FIG. 3A is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 1 from above, while FIG. 3B is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 1 from below. In FIG. 1 and FIG. 2, the x-direction, y-direction, and z-direction are defined as shown in the drawings.

A circuit assembly 1 illustrated in the drawings may be used for a digital signal image receiver (not shown) that receives a high-speed differential signal or the like. The

circuit assembly 1 includes a wiring substrate 2, an electrical connector 3, and a reinforcement member 4. The electrical connector 3 is a component that electrically connects a wiring substrate 2 to a circuit board 5 mounted with integrated circuits (ICs).

First, the wiring substrate 2 will be described. As illustrated in FIG. 3, the wiring substrate 2 is a substrate including Flexible Printed Circuits (FPC) or the like. Signal lines and ground lines 6a are printed as conductive wiring on an insulating substrate constructed from a material such as polyimide or the like with a thickness of a few tens of μm. At an edge portion of one surface of the insulating substrate, a plurality of terminals 6 electrically connected to the signal lines and ground lines 6a are arranged in parallel lines. For the conductive wiring that forms the wiring pattern, conductive metal foil, such as copper foil or the like, with a thickness of a few tens of μm can be used.

A leading edge portion 2A of the wiring substrate 2 having the above-described configuration is formed to be wider than other portions. The leading edge portion 2A of the wiring substrate 2 is generally rectangular and has formed therein engagement holes 7 (fixture receiving means). In other words, the fixture receiving means are holes formed at both end portions of the wiring substrate. Specifically, the engagement holes 7 are generally rectangular and are formed at both width-direction (x-direction) end portions of the wiring substrate 2. A plurality (two in this case) of engagement holes 7 is aligned in a longitudinal direction (y-direction) at each end of the wiring substrate 2. Further, cut-away portions 8 are formed in the leading edge portion 2A. Each cut-away portion 8 is generally rectangular and is provided between the engagement holes 7 and 7.

Next, the electrical connector 3 will be described. FIG. 4 is an exploded perspective view of the electrical connector of the circuit assembly illustrated in FIG. 1. As illustrated in FIG. 4, the electrical connector 3 includes a housing 10, substrate holding portions (fixture means) 12a and 12b, and connection elements 14. Approximate external

dimensions of the electrical connector 3 are, for example, length 12.50 mm, width 4.50 mm, and height 1.00 mm. Note that in FIG. 4, the connection elements 14 are omitted for ease of description.

The housing 10 is formed from a material with electrical insulation properties. For the material with electrical insulation properties, various resins including industrial plastics such as polybutylene terephthalate (PBT), Polycarbonate (PC), Polystyrene sulfphonate (PSS), Liquid Crystal Polymer (LCP) (Plastic), nylon, and the like can be used. The housing 10, for example, may be formed by injecting molding.

The housing 10 is constructed from a first sidewall portion 20, a second sidewall portion 21, and a pair of joining portions 22 and 23 that connect to the first sidewall portion 20 and the second sidewall portion 21. The first sidewall portion 20 and second sidewall portion 21 are columnar members with a generally rectangular cross-sectional profile, which are in mutual opposition across a predetermined gap, while being generally parallel. Top faces 20a and 21a of the first sidewall portion 20 and the second sidewall portion 21 are flat surfaces and are positioned at the same height.

The joining portions 22 and 23 are provided respectively at both longitudinal direction (x-direction) end portions of the first sidewall portion 20 and second sidewall portion 21. The joining portion 22 and the joining portion 23 have similar constructions. Here, the construction is described with reference to the joining portion 22 as an example.

The joining portion 22 is constructed from a base portion 25, and first through third projecting portions 26, 27, and 28. The base portion 25 is connected to one longitudinal-direction end portion of the first and second sidewall portions 20 and 21 respectively. The base portion 25 is a plate-like member and extends in a direction perpendicular to the first sidewall portion 20 and the second sidewall portion 21 (y-direction). Engagement grooves 25a are formed in the base portion 25 to allow attachment of the substrate holding portions

12a and 12b described later. The engagement grooves 25a are provided in a pair straddling the third projecting portion 28 and extend in the longitudinal direction of the first and second sidewall portions 20 and 21.

The first through third projecting portions 26 to 28 project upward from the base portion 25 with tip ends positioned higher than the top faces 20a and 21a of the first sidewall portion 20 and the second sidewall portion 21. The first projecting portion 26 and the second projecting portion 27 are provided at the longitudinal-direction (width direction of the housing 10, the y-direction) end portions of the base portion 25 and are arranged so as to oppose each other. The third projecting portion 28 is arranged at a central portion of the width direction of the base portion 25 (longitudinal direction of the housing 10, the x-direction) and projects upward from the top face of the base portion 25.

At a top part of the first through third projecting portions 26 to 28, guide faces 26a, 27a, and 28a are formed respectively. The guide faces 26a, 27a, and 28a have an inclined face (taper) sloping downward toward the inner side of the housing 10. Bottom edges of the guide faces 26a, 27a, and 28a are at generally the same height as the top faces 20a and 21a of the first and second sidewall portions 20 and 21. The guide faces 26a, 27a, and 28a function as a positioning mechanism when the wiring substrate 2 is arranged in the housing 10.

In the housing 10, a generally rectangular open portion K is demarcated by the first sidewall portion 20, the second sidewall portion 21, and the joining portions 22 and 23. The housing 10 is therefore open in one direction with an open surface OS being demarcated by the top faces 20a and 21a of the first sidewall portion 20 and the second sidewall portion 21. Note that, as illustrated in FIG. 9, the bottom surface of the housing 10 is in the same plane. With this arrangement, the housing 10 is securely fixed to the circuit board 5.

FIG. 5 is an enlarged partial perspective view illustrating the electrical connector. FIG. 6A is a side view illustrating a state prior to coupling the wiring substrate and the

electrical connector, while FIG. 6B is a side view illustrating a state after coupling the wiring substrate and the electrical connector. FIG. 7A is an enlarged partial sectional view illustrating a state prior to coupling the wiring substrate and the electrical connector, while FIG. 7B is an enlarged partial sectional view illustrating a state after coupling the wiring substrate and the electrical connector.

The substrate holding portions 12a and 12b illustrated in FIG. 5 are means to hold and secure the wiring substrate 2 in the housing 10. As illustrated in FIG. 5, the substrate holding portions 12a and 12b are formed from a material such as a metal with elastic properties. The substrate holding portion 12a arranged in the joining portion 22 and the substrate holding portion 12b arranged in the joining portion 23 have a similar construction. In the following, the construction is described with reference to the substrate holding portion 12b arranged in the joining portion 23 as an example.

The substrate holding portion 12b is attached to one longitudinal end portion of the first sidewall portion 20 and second sidewall portion 21, which is to say attached to the joining portion 23 of the housing 10. The substrate holding portion 12b includes an engagement portion configured to allow engagement with holes in the wiring substrate and a base portion that is contiguous with the engagement portion and fixed to the housing. Specifically, the substrate holding portion 12b is flexible, and includes a base portion 30, an engagement portion 31, and a joining portion 32 that joins the base portion 30 and the engagement portion 31. The base portion 30, engagement portion 31, and the joining portion 32 are integrally formed using a metal plate.

The base portion 30 is a plate-like member, and includes a long portion 30a that extends in the longitudinal direction (y-direction) of the joining portion 22, and a pair of protruding portions 30b and 30c that protrude, in a single direction, from width direction sides

of the long portion 30a (see FIG. 5). The base portion 30 is arranged on a bottom surface side of the joining portion 22.

The engagement portions 31 are portions that engage with the engagement holes 7 of the wiring substrate 2 and engagement holes 9 of the reinforcement member 4 described below. As illustrated in FIG. 6, the engagement portion 31 is configured from a top face portion 31a, a first side face portion 31b contiguously provided at one end side of the top face portion 31a, and a second side face portion 31c contiguously provided between the top face portion 31a and the joining portion 32.

The top face portion 31a is a generally rectangular when viewed from above and has dimensions generally equal to those of the engagement holes 7 of the wiring substrate 2 and the engagement holes 9 of the reinforcement member 4. A latch portion 34 is provided on the top face portion 31a. The latch portion 34 is a portion for latching on the wiring substrate 2 and the reinforcement member 4, and is provided on a side face of the top face portion 31a. The latch portion 34 includes an inclined face sloping downward and outward from the top surface of the top face portion 31a.

The first side face portion 31b and the second side face portion 31c are portions that abut with the engagement holes 7 and the engagement holes 9. A width of the first side face portion 31b and the second side face portion 31c is set to be larger than the diameter of the engagement holes 7 and the engagement holes 9. A curved surface that bulges outward is provided at an external surface of the first side face portion 31b. Further, a gap D is provided between the tip of the first side face portion 31b and the joining portion 32. The engagement portion 31 is provided so as to be flexible by an amount corresponding to the gap D when pressed down as the wiring substrate 2 is pressed in.

The joining portion 32 is integrally connected with one end portion of the base portion 30 and one end portion of the engagement portion 31. The joining portions 32 are

generally U-shaped and are inserted in the engagement grooves 25a formed in the joining portions 22 and 23 of the housing 10. Thus, the substrate holding portions 12a and 12b are fixed to the joining portions 22 and 23. When engaged with the fixture receiving means, the fixture means apply opposing forces to the wiring substrate, and these forces are directed in the lateral direction away from the center of the wiring substrate. Specifically, when the substrate holding portions 12a and 12b are engaged with the engagement holes 7 of the wiring substrate 2 and the engagement holes 9 of the reinforcement member 4, tensile forces are applied to the wiring substrate 2 and the reinforcement member 4, pulling in opposing directions from a center portion (center) toward both end portions (lateral direction), which is to say outward in the x-direction. Further, the wiring substrate 2 and the reinforcement member 4 are hooked by the latch portion 34 of the top face portion 31a, thereby fixing the wiring substrate 2 and the reinforcement member 4 to the electrical connector 3.

Next, the connection elements 14 will be described. As illustrated in FIG. 2, a plurality (30 here) of connection elements 14 are disposed in the housing 10. The connection elements 14 are disposed in a space S demarcated by the first sidewall portion 20 and the second sidewall portion 21 in the housing 10 and have contact points where the wiring substrate 2 is exposed. A width of the connection element 14 is, for example, approximately 0.15 mm and a pitch of the connection elements 14 in the arrangement is, for example, 0.15 mm. The connection elements 14 can be formed by punching from a plate of uniform thickness using a pressing process. It is therefore possible to easy and accurately process the connection elements 14 having a bent and curved form.

The connection elements 14 are supported by being fixed at both ends to the first sidewall portion 20 and the second sidewall portion 21. Specifically, the connection elements 14, for example, may be formed integrally with the housing 10 when the housing 10 is injection molded or may be press fitted in the housing 10 and fixed to the housing 10.

Adjacent connection elements 14 are arranged to point in opposing directions. As a result, the connection elements 14 are arranged so that contact points with the wiring substrate 2 are staggered over the longitudinal direction of the housing 10. A specific configuration of the connection elements 14 is described with reference to FIG. 8 and FIG. 9. FIG. 8 is a perspective view of a connection element. FIG. 9 is a sectional view through IX-IX in FIG. 2.

As illustrated in FIG. 8 and FIG. 9, the connection element 14 includes: a connection terminal 40, a first end portion 41 that is embedded in a predetermined position in the first sidewall portion 20; a second end portion 42 that is embedded in a predetermined position of the second sidewall portion 21; a first portion 43 that is contiguous on the first end portion 41 side and extends to the second sidewall portion 21 side; a second portion 44 that is contiguous on the second end portion 42 side and extends to the first sidewall portion 20 side, and a central portion 45 that connects the first portion 43 and the second portion 44 with a bent part, wherein the second portion 44 includes a plurality of linear portions and a plurality of bent portions, one linear portion of the plurality of linear portions and the first portion 43 are generally parallel and inclined with respect to an open surface OS, and the central portion 45 moves elastically toward the open surface OS when the electrical connector 3 is coupled to the wiring substrate. The connection terminal 40, the first end portion 41, the second end portion 42, the first portion 43, the second portion 44, and the central portion 45 are integrally formed and located in the same plane.

The connection terminal 40 is a portion at one end of the connection elements 14 and is configured to have a linear shape. The connection terminal 40 electrically contacts a contact portion (not shown in the drawings) provided on the circuit board 5. The connection terminal 40 is located on the outward side of the external face of the first sidewall portion 20.

The first end portion 41 is a portion between the connection terminal 40 and the first portion 43. A part of the first end portion 41 is embedded in the first sidewall portion 20,

and supported by and fixed to the first sidewall portion 20. The first end portion 41 is configured to have a linear shape, and extends generally parallel to the connection terminal 40 at a higher position than the connection terminal 40. A part of the second end portion 42 is embedded in the second sidewall portion 21, and is supported by and fixed to the second sidewall portion 21. Thus, the connection elements 14 are fixed to and supported by the housing 10 at the two locations of the second end portion 42 and the first end portion 41.

The first portion 43 is a portion between the first end portion 41 and the central portion 45. The first portion 43 is provided contiguous to the first end portion 41 and extends with an incline from the bottom surface side of the first sidewall portion 20 toward the open surface OS side. The second portion 44 is a portion between the second end portion 42 and the central portion 45. The second portion 44 includes a first linear part (linear portion) 44a, a second linear part 44b, a third linear part 44c, a first bent part (bent portion) 44d, and a second bent part 44e.

The first linear part 44a and the second linear part 44b are joined by the first bent part 44d that is generally V-shaped. The first linear part 44a extends toward the first sidewall portion 20 side from the second end portion 42, and has a downward incline from the second sidewall portion 21 side to the first sidewall portion 20 side. The second linear part 44b extends toward the first sidewall portion 20 side from the first bent part 44d, and has an upward incline from the second sidewall portion 21 side to the first sidewall portion 20 side.

The second linear part 44b and the third linear part 44c are joined by the second bent part 44e that is generally V-shaped. The third linear part 44c extends toward the second sidewall portion 21 side from the second bent part 44e, and has an upward incline from the first sidewall portion 20 side to the second sidewall portion 21 side. In other words, the third linear part 44c is bent back on the second linear part 44b by way of the second bent part 44e.

The central portion 45 includes a bent portion 45a with a U-shaped bend and joins the first portion 43 and the second portion 44 in such a way that the first portion 43 and the third linear part 44c of the second portion 44 are generally parallel with a predetermined gap therebetween. A top part of the central portion 45 is a contact point with a terminal 6 of the wiring substrate 2. The central portion 45 is inclined with respect to the top faces 20a and 21a of the first sidewall portion 20 and the second sidewall portion 21, which is to say the open surface OS, and protrudes higher than (outward of) the open surface OS. As a result, the connection element 14 enables contact with the terminal 6 of the wiring substrate 2 that is mounted from above.

Note that the connection element 14 adjacent to the connection element 14 described above has a configuration equivalent to the above configuration but flipped from right to left. Specifically, in the connection element 14 adjacent to the connection element 14 described above, the connection terminal 40 is located outward of the second sidewall portion 21 and the first end portion 41 is fixed to the second sidewall portion 21. The second end portion 42 is fixed to the first sidewall portion 20. With such a configuration, the contact points of the connection elements 14 are disposed in staggered form.

By providing the plurality of bent portions, the connection elements 14 of the above-described configuration an elastic property. Thus, when the connection elements 14 are pressed downward as the wiring substrate 2 is mounted, an elastic reaction force acts to move the wiring substrate 2 upward toward the open surface OS side. Also, when the wiring substrate 2 is mounted, contact points on the connection elements 14 slide along terminals 6 of the wiring substrate 2.

The reinforcement member 4 is member which supports the fixing of the wiring substrate 2 when the wiring substrate 2 is mounted on the housing 10. The reinforcement member 4 is generally rectangular and has a shape that is generally the same as the leading

edge portion 2A of the wiring substrate 2. The reinforcement member 4 is, for example, a rigid material such as a glass epoxy plate, a paper phenol plate, a polyimide film, a polyester film, a metal plate, or the like, and is of a thickness equal to the thickness of the wiring substrate 2. The reinforcement member 4 has engagement holes 9 formed at locations corresponding to the engagement holes 7 of the wiring substrate 2, which is to say at locations corresponding to engagement portions 31 of the substrate holding portions 12a and 12b of the housing 10. The reinforcement member 4 also has cut-away portions 4a formed therein. The cut-away portions 4a are generally rectangular and are provided between the engagement holes 9.

The reinforcement member 4 is arranged on a surface of the wiring substrate 2 (surface on opposite side of surface where the terminals 6 are provided) and the engagement holes 9 engage with the substrate holding portions 12a and 12b of the housing 10. Thus, a tensile force is applied to the reinforcement member 4 pulling this reinforcement member 4 outward in a similar manner to the wiring substrate 2. Accordingly, the reinforcement member 4 presses downward on the wiring substrate 2, making contacts between the terminals 6 of the wiring substrate 2 and the connection elements 14 of the electrical connector 3 more reliable in the circuit assembly 1.

Next, an assembly method for the circuit assembly 1 will be described. FIG. 10 is a view illustrating an assembly procedure for the circuit assembly.

As illustrated in FIG. 10, first, the electrical connector 3 is arranged on the circuit board 5. Next, the wiring substrate 2 is arranged over the electrical connector 3, and the wiring substrate 2 is then placed on the electrical connector 3 (housing 10). At this point, the position of the wiring substrate 2 is determined by the first through third projecting portions 26 to 28 of the housing 10. Specifically, the wiring substrate 2 is arranged in the predetermined position by engaging the third projecting portions 28 of the housing 10 with

the cut-away portions 8 of the wiring substrate 2 and using guide surfaces 26a and 27a. Next, the wiring substrate 2 is pressed in and the engagement portion 31 of the substrate holding portions 12a and 12b are engaged with the engagement holes 7 of the wiring substrate 2. At this point, the wiring substrate 2 is hooked by the latch portion 34 of the engagement portion 31, thereby fixing the wiring substrate 2 to the electrical connector 3.

When the wiring substrate 2 and the electrical connector 3 are coupled, a tensile force is applied to the wiring substrate 2 by the substrate holding portions 12a and 12b. The tensile force acts in opposite directions from the center of the wiring substrate 2 (directions in which the substrate holding portions 12a and 12b are provided). In other words, a force is applied to the wiring substrate 2, pulling the two edge portions of the wiring substrate 2 in the outward direction. Accordingly, a force acts pressing downward over the entire surface of the wiring substrate 2, ensuring a reliable connection between the terminals 6 of the wiring substrate 2 and the connection elements 14 of the electrical connector 3.

Next, the reinforcement member 4 is arranged over the wiring substrate 2 and the reinforcement member 4 is placed on the wiring substrate 2. Then, the reinforcement member 4 is pressed to engage the engagement portion 31 of the substrate holding portions 12a and 12b with the engagement holes 9 of the reinforcement member 4. Thus, a tensile force is applied to the reinforcement member 4 in the same way as the wiring substrate 2. Note that the reinforcement member 4 may be arranged at the same time as the wiring substrate 2 is placed on the electrical connector 3. As described above, in the present embodiment, the wiring substrate 2 and the reinforcement member 4 are layered in this order on the electrical connector 3 to assemble the circuit assembly 1.

As described above, in the present embodiment the housing 10 of the electrical connector 3 has the first sidewall portion 20 and the second sidewall portion 21 arranged so as to oppose each other, and the first sidewall portion 20 and the second sidewall portion 21

demarcate the open surface OS. Further, the connection elements 14 are arranged in rows between the first sidewall portion 20 and the second sidewall portion 21 while at the same time being fixed by the first sidewall portion 20 and the second sidewall portion 21. A central portion 45 (contact points with the wiring substrate 2) of each connection element 14 protrudes outward and is exposed at the open surface OS. The substrate holding portions 12a and 12b are provided at both end portions of the housing 10 in locations corresponding to the engagement holes 7 provided in the wiring substrate 2.

In an electrical connector 3 of this construction, the connection elements 14 project from the open surface OS. A connection between the connection elements 14 and the terminals 6 of the wiring substrate 2 can therefore be made by mounting the wiring substrate 2 on the electrical connector 3. Hence, when the wiring substrate 2 is attached to the electrical connector 3, the wiring substrate 2 is mounted on the electrical connector 3 from above the electrical connector 3 and then the wiring substrate 2 is pressed from above. In other words, in the circuit assembly 1 of the present embodiment, the wiring substrate 2 can be mounted on the electrical connector 3 by a PFC 2. Hence, an operation to insert the wiring substrate 2 horizontally in the manner of the conventional technology is not required. Thus, the mounting of the wiring substrate 2 on the electrical connector 3 mounted on the circuit board 5 can be automated.

When the substrate holding portions 12a and 12b are engaged in the engagement holes 7 of the PFC 2, a tensile force is applied to the wiring substrate 2 pulling the wiring substrate 2 outward. Hence, even with a configuration in which the wiring substrate 2 is placed on the electrical connector 3, the housing 10 and the wiring substrate 2 can be reliably fixed together, ensuring a favorable electrical connection between the connection elements 14 and the terminals 6.

Moreover, the connection elements 14 are constructed to have a plurality of bent portions (folded back points). With this construction, the length of the connection elements 14 can be ensured. Further, the connection elements 14 have a so-called double-hold configuration in which the first end portion 41 and the second end portion 42 are held by the first sidewall portion 20 and second sidewall portion 21. Hence, in comparison to a configuration in which a single end portion is supported, the force acting toward the open surface OS, which is to say the reactive force (elastic force) applied when the wiring substrate 2 is mounted, is larger. Consequently, a more reliable connection can be achieved between the connection elements 14 and the terminals 6 of the wiring substrate 2.

Adjacent connection elements 14 are arranged to have an opposing orientation reversed from right to left. Hence, adjacent central portions 45 of the connection elements 14 are not in alignment. Consequently, even when connection elements 14 flex under pressure, contact between the adjacent central portions 45 can be prevented. Thus, the connection elements 14 can be arranged with a short pitch.

Note that while in the above-described embodiment the wiring substrate 2 and the reinforcement member 4 are separate members, the wiring substrate 2 and the reinforcement member 4 may be formed as a single body.

Moreover, while in the above embodiment, the connection terminal 40 is illustrated with a construction in which the connection terminal 40 protrudes beyond the external face of the first sidewall portion 20 or the second sidewall portion 21, the construction of the connection terminal 40 is not limited to this. The connection terminal 40 can have any construction that secures electrical contact with the circuit board 5 and can be set appropriately for the configuration of the circuit board 5.

Besides the construction of the above embodiment, the circuit assembly 1 may have the construction illustrated in FIG. 11. FIG. 11 is a perspective view illustrating another

mode of the first embodiment. As illustrated in FIG. 11, in a circuit assembly 1A, a generally cylindrical protuberance 46 is provided in a top face 20a of the first sidewall portion 20 of the electrical connector 3A, projecting upward from the top face 20a. To receive the protuberance 46, cut-away portions 47 and 48 are provided in locations corresponding to the protuberance 46 in the wiring substrate 2B and the reinforcement member 4A. According to this configuration of the circuit assembly 1A, the position of the wiring substrate 2 can be easily determined when the wiring substrate 2 is mounted on the electrical connector 3. Note that the location and number of protuberances 46 is not limited to the construction shown in FIG. 10.

Further, in the above embodiment, the substrate holding portions 12a and 12b that fix the wiring substrate 2 and the reinforcement member 4 are provided at both end portions of the housing 10, but means to hold the wiring substrate 2 and the like may be provided at another location as well. Specifically, the fixture means may be provided at the second sidewall portion 21.

Further, while in the above embodiment the connection elements 14 are held by the first sidewall portion 20 and the second sidewall portion 21, a construction in which only one end of the connection elements 14 are held is, naturally, also acceptable.

[Second Embodiment]

Next, the second embodiment will be described. FIG. 12 is a perspective view of a circuit assembly according to a second embodiment. FIG. 13A is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 12 from above, while FIG. 13B is a perspective view illustrating the wiring substrate of the circuit assembly shown in FIG. 12 from below. FIG. 14A is a perspective view illustrating the electrical connector of the circuit assembly shown in FIG. 12 from above, while FIG. 14B is a perspective view

illustrating the electrical connector of the circuit assembly shown in FIG. 12 from below. FIG. 15 is a perspective view illustrating a state after coupling of the wiring electrical connector and the wiring substrate. In FIG. 12, the x-direction, the y-direction, and the z-direction are defined as shown.

In FIGS. 12 to 14, a circuit assembly 50 includes a wiring substrate 51, an electrical connector 52, and a pressing member 53. An electrical connector 52 is a component that electrically connects a wiring substrate 51 to a circuit board (not shown in the drawings) mounted with ICs or the like.

First, the wiring substrate 51 will be described. As illustrated in FIG. 13, the wiring substrate 51 includes signal lines and ground lines 54 printed as conductive wiring on an insulating substrate constructed from a material such as polyaimide with a thickness of a few tens of μm, similar to the wiring substrate 2 described above. At an edge portion of one surface of the insulating substrate, a plurality of terminals 54 electrically connected to the signal lines and ground lines 54a are arranged in parallel lines.

A leading edge portion 51A of the wiring substrate 51 having the above-described configuration is formed to be wider than other portions. The leading edge portion 51A of the wiring substrate 51 is generally rectangular and has formed therein engagement holes 55 (fixture receiving means). Specifically, the engagement holes 7 are generally round shaped and are formed at both width-direction (x-direction) end portions of the wiring substrate 51. A plurality (two in this case) of engagement holes 55 is aligned in a longitudinal direction (y-direction) at each end of the wiring substrate 51.

A reinforcement member 56 is arranged on a surface of the wiring substrate 51 (surface on opposite side of the surface where the terminals 54 are provided). The reinforcement member 56 is formed using a material such as polyimide or the like and is

arranged on the leading edge portion 51A of the wiring substrate 51. The engagement holes 55 of the wiring substrate 51 pierce through the reinforcement member 56.

Next, the electrical connector 52 will be described. As illustrated in FIG. 14, the electrical connector 52 includes a housing 60, pressing member holding portions (fixture means) 61a and 61b, and connection elements 14.

The housing 60 is constructed from a first sidewall portion 63, a second sidewall portion 64, and a pair of joining portions 65 and 66 that connect to the first sidewall portion 63 and the second sidewall portion 64. The first sidewall portion 63 and second sidewall portion 64 are columnar members with a generally rectangular cross-sectional profile, which are in mutual opposition across a predetermined gap, while being generally parallel. Top faces 63a and 64a of the first sidewall portion 63 and the second sidewall portion 64 are flat surfaces and are positioned at the same height.

A protruding portion 67 is provided on the second sidewall portion 64. The protruding portion 67 is a member that is generally rectangular in cross-section, and protrudes from the top face 64a of the second sidewall portion 64. The protruding portion 67 is arranged along an exterior surface of the second sidewall portion 64 and also has a predetermined gap in a central portion thereof. The protruding portion 67 functions as a mechanism to determine the position of the wiring substrate 51.

The joining portions 65 and 66 are provided respectively at both longitudinal direction (x-direction) end portions of the first sidewall portion 63 and the second sidewall portion 64. The joining portion 65 and the joining portion 66 have similar constructions. Here, the construction is described with reference to the joining portion 65 as an example.

[0073]

The joining portion 65 is provided with the projecting portions (fixture means) 68a and 68b. A plurality (two here) of the projecting portions 68a and 68b are provided with a

predetermined gap in the y-direction on the joining portion 65. The projecting portions 68a and 68b are provided projecting upward from the top face of the joining portion 65, and each have a generally semi-circular profile in cross-section. The projecting portions 68a and 68b are portions that are inserted into the engagement holes 55 of the wiring substrate 51 and that, through cooperation with the hook tabs 72a and 72b of the pressing member holding portions 61a and 61b described later, hold and fix the wiring substrate 51.

In the housing 60, the first sidewall portion 63, the second sidewall portion 64 and the joining portions 65 and 66 demarcate a rectangular open portion K. The housing 60 is therefore open in one direction with an open surface OS being demarcated by the top faces 63a and 64a of the first sidewall portion 63 and the second sidewall portion 64.

An insulating sheet IS is provided on a back face of the housing 60. On the back face side of the housing 60, the insulating sheet IS blocks the open portion K demarcated by the first sidewall portion 63, the second sidewall portion 64, and the joining portions 65 and 66. The insulating sheet IS electrically insulates the circuit board from the connection elements 14.

The pressing member holding portions 61a and 61b are portions that fix a pressing member 53 to the housing 60. The pressing member holding portions 61a and 61b are provided on the joining portions 65 and 66. The pressing member holding portion 61a and the pressing member holding portion 61b have a similar construction. Here, the construction is described with reference to the pressing member holding portion 61a as an example.

The pressing member holding portion 61a includes a base portion 70 arranged along the top face of the joining portion 65, and latch portions 71a and 71b arranged at both (y-direction) end portions of the base portion 70. Hook tabs 72a and 72b are provided on the base portion 70 at locations corresponding to the projecting portions 68a and 68b. The hook tabs 72a and 72b are arranged to oppose the projecting portions 68a and 68b, and project

upward from the top face of the base portion 70. The hook tabs 72a and 72b have a curved form, and form protrusions with respect to the projecting portions 68a and 68b. As a result of the hook tabs 72a and 72b, the wiring substrate 51 and a pressing member 53 (described later) are acted upon by a tensile force pulling the wiring substrate 51 and the pressing member 53 outward in the longitudinal direction of the housing 60 (x-direction). The wiring substrate 51 and the pressing member 53 are thus held by and fixed to the housing 60.

The latch portions 71a and 71b are provided with hook tabs 73a and 73b respectively. As illustrated in FIG. 14A, the hook tabs 73a (73b) are inclined downward and outward in the width direction of the housing 60.

The connection elements 14 have a similar construction to those of the first embodiment. Specifically, the connection elements 14 are supported by being fixed at both ends to the first sidewall portion 63 and the second sidewall portion 64. Adjacent connection elements 14 are arranged to point in opposing directions. As a result, the connection elements 14 are arranged so that contact points with the wiring substrate 51 are staggered over the longitudinal direction of the housing 10.

The connection element 14 includes the connection terminal 40, the first end portion 41, the second end portion 42, the first portion 43, the second portion 44, and the central portion 45. The connection terminal 40, the first end portion 41, the second end portion 42, the first portion 43, the second portion 44, and the central portion 45 are integrally formed and located in the same plane.

FIG. 16A is a perspective view illustrating a pressing member of the circuit assembly shown in FIG. 12 from above, while FIG. 16B is a perspective view illustrating a pressing member of the circuit assembly shown in FIG. 12 from below. The pressing member 53 illustrated in FIG. 16 is arranged on the wiring substrate, and is fixed to the housing, and the wiring substrate is pressed toward the housing. Specifically, the pressing member 53 is a

member that presses the wiring substrate 51 toward the housing 60 side of the electrical connector 52. The pressing member 53 is formed from a material such as a metal and includes a pressing portion 75, a side face portion 76, and a pair of engagement portions 77 and 78. The pressing portion 75, the side face portion 76, and the engagement portions 77 and 78 are integrally formed using a metal plate.

The pressing portion 75 is a portion that contacts the surface of the wiring substrate 51 and has a plate-like form. The pressing portion 75 has engagement holes 79 formed at locations corresponding to the engagement holes 55 of the wiring substrate 51, which is to say at locations corresponding to projecting portions 68a and 68b of the electrical connector 52. The side face portion 76 projects from an edge portion of one longitudinal-direction surface of the pressing portion 75. The side face portion 76 is provided along the pressing portion 75. At both end portions of the side face portion 76, engagement holes 80a and 80b are formed for engaging with engagement tabs 73b of the latch portions 71a and 71b of the pressing member holding portions 61a and 61b.

The engagement portions 77 and 78 are arranged, respectively, at the two end portions of the other side face of the pressing portion 75. The engagement portions 77 and 78 extend in a surface direction of the pressing portion 75 from the other side face of the pressing portion 75 and, at end portions thereof, project in the same direction as the side face portion 76. The engagement portions 77 and 78 have formed therein engagement holes 81 and 82 which engage with the hook tabs 73a of the latch portions 71a and 71b of the pressing member holding portions 61a and 61b. As illustrated in FIG. 12, in the circuit assembly 50, the wiring substrate 51 is arranged between the pair of engagement portions 77 and 78.

Next, an assembly method for the circuit assembly 50 will be described. First, the electrical connector 52 is arranged on the circuit board. Next, the wiring substrate 51 is arranged over the electrical connector 52, and the wiring substrate 51 is then placed on the

electrical connector 52 (housing 60). Next, the wiring substrate 51 is pressed in, causing the projecting portions 68a and 68b of the housing 60 and the hook tabs 72a and 72b of the pressing member holding portions 61a and 61b to engage with the engagement holes 55 of the wiring substrate 51. At this point, the wiring substrate 51 is hooked by the latch portions 71a and 71b of the pressing member holding portions 61a and 61b, and the wiring substrate 51 is thereby fixed to the electrical connector 52.

After fixing the wiring substrate 51 to the electrical connector 52, the pressing member 53 is arranged on the wiring substrate 51 and the reinforcement member 56 is mounted on the wiring substrate 51. Next, the pressing member 53 is pressed in, causing the projecting portions 68a and 68b of the housing 60 and the hook tabs 72a and 72b of the pressing member holding portions 61a and 61b to engage with the engagement holes 79 of the pressing member 53. Further, the hook tabs 73a and 73b of the latch portions 71a and 71b of the pressing member holding portions 61a and 61b are engaged with the engagement holes 80a, 80b, 81, and 82 of the pressing member 53.

Hence, a force is applied pressing uniformly on the wiring substrate 51 from the pressing member 53 toward the electrical connector 52 side. Accordingly, the terminals 54 of the wiring substrate 51 and the connection elements 14 of the electrical connector 52 make a reliable contact. Note that the pressing member 53 may be arranged at the same time as the wiring substrate 51 is placed on the electrical connector 52. As described above, in the present embodiment, the wiring substrate 51 and the pressing member 53 are layered in this order on the electrical connector 52 to assemble the circuit assembly 50.

As described above, in the present embodiment the housing 60 of the electrical connector 52 has the first sidewall portion 63 and the second sidewall portion 64 arranged so as to oppose each other, and the first sidewall portion 63 and the second sidewall portion 64 demarcate the open surface OS. Further, the connection elements 14 are arranged in rows

between the first sidewall portion 63 and the second sidewall portion 64 while at the same time being fixed by the first sidewall portion 63 and the second sidewall portion 64. A central portion 45 (contact points with the wiring substrate 2) of each connection element 14 protrudes outward and is exposed at the open surface OS.

In the electrical connector 52 of this construction, the connection elements 14 project from the open surface OS. A connection between the connection elements 14 and the terminals 54 of the wiring substrate 51 can therefore be made by placing the wiring substrate 51 on the electrical connector 52. Hence, when the wiring substrate 51 is attached to the electrical connector 52, the wiring substrate 51 is mounted on the electrical connector 52 from above the electrical connector 52 and then pressed from above the wiring substrate 51. In other words, in the circuit assembly 50 of the present embodiment, the wiring substrate 51 can be mounted on the electrical connector 52 by pressing down on the wiring substrate 51 from above.

Further, due to the pressing member 53, the wiring substrate 51 is pressed uniformly over an entire surface of the wiring substrate 51 toward the housing 60 side. Accordingly, the connection between the connection elements 14 and the terminals 54 of the wiring substrate 51 can be made more secure. As a result, an improvement in reliability of the circuit assembly 50 can be realized.

Note that while in the embodiment described above, the connection between the terminals 54 of the wiring substrate 51 and the connection elements 14 is secured by pressing the wiring substrate 51 with the pressing member 53, further additions are acceptable. A mechanism that applies an outward tensile force to the wiring substrate 51 (such as substrate holding portions 12a and 12b of the first embodiment) may be further added.

[Third Embodiment]

Next, a third embodiment will be described. FIG. 17 is a perspective view of an electrical connector of the circuit assembly according to the third embodiment. FIG. 18 is a sectional view through A-A in FIG. 17.

As illustrated in FIG. 17 and FIG. 18, an electrical connector 90 includes a housing 91, substrate holding portions 92a and 92b, and connection elements 93. The housing 91 is constructed from a first sidewall portion 95, a second sidewall portion 96, a third sidewall portion 97, and a pair of joining portions 98 and 99 that connect to the first through third sidewall portions 95 to 97.

The first sidewall portion 95, the second sidewall portion 96, and the third sidewall portion 97 are columnar members with a generally rectangular cross-sectional profile, which are in mutual opposition across a predetermined gap, while being generally parallel. The third sidewall portion 97 is arranged between the first sidewall portion 95 and the second sidewall portion 96. Respective top faces 95a, 96a, and 97a of the first sidewall portion 95, the second sidewall portion 96, and the third sidewall portion 97 are flat surfaces and are positioned at the same height.

The joining portions 98 and 99 are provided respectively at both longitudinal direction (x-direction) end portions of the first through third sidewall portions 95 to 97. The joining portion 98 and the joining portion 99 have similar constructions. Here, the construction is described with reference to the joining portion 98 as an example.

The joining portion 98 is constructed from a base portion 100 and latch portions 101a and 101b. The base portion 100 is connected to one longitudinal-direction end portion of each of the first through third sidewall portions 95 to 97. The base portion 100 is a plate-like member and extends in a direction perpendicular to the first through third sidewall portions 95 to 97 (y-direction).

The latch portions 101a and 101b project upward from the base portion 100 with tip ends thereof located higher than the top faces 95a, 96a, and 97a of the first through third sidewall portions 95 to 97. A latch portion 102 projecting toward an inner side of the housing 91 is provided on each of the latch portions 101a and 101b. The latch portion 102 engages with a wiring substrate not shown in the drawings.

Further, guide faces 103a and 103b are formed on the latch portions 101a and 101b respectively. The guide faces 103a and 103b are inclined faces (tapers) sloping downward toward the inner side of the housing 91. Bottom edges of the guide faces 103a and 103b are at generally the same height as the top faces 95a and 96a of the first and second sidewall portions 95 and 96. The guide faces 103a and 103b function as a positioning mechanism when the wiring substrate is arranged on the housing 91.

In the housing 91, the first sidewall portion 95, the second sidewall portion 96, the third sidewall portion 97, and the joining portions 98 and 99 demarcate rectangular open portions K1 and K2. The housing 91 is therefore open in one direction with an open surface OS being demarcated by the top faces 95a, 96a, and 97a of the first through third sidewall portions 95 to 97.

The substrate holding portions 92a and 92b are means to hold and fix the wiring substrate in the housing 91. The substrate holding portions 92a and 92b are formed from a material such as a metal with elastic properties. The substrate holding portion 92a arranged in the joining portion 98 and the substrate holding portion 92b arranged in the joining portion 99 have a similar construction. In the following, the construction is described with reference to the substrate holding portion 92a arranged in the joining portion 98 as an example. Note that the substrate holding portions 92a and 92b are formed integrally with the housing 91 using injection molding.

The substrate holding portion 92a is attached to one longitudinal end portion of the first through third sidewall portions 95 to 97, which is to say attached to the joining portion 98 of the housing 91. The substrate holding portion 92a is flexible, and includes a base portion 110 and an engagement portion 111. The base portion 110 and the engagement portion 111 are integrally formed using a metal plate.

The base portion 110 is a plate-like member extending in the longitudinal direction (y-direction) of the joining portion 98. The engagement portion 111 is a portion that engages in engagement holes in a wiring substrate not shown in the drawings. As illustrated in FIG. 17, the engagement portion 111 is configured from a top face portion 111a, a first side face portion 111b contiguously provided at one end side of the top face portion 111a, and a second side face portion 111c contiguously provided between the top face portion 111a and the base portion 110.

The top face portion 111a is generally rectangular when viewed from above and is of generally the same size as the engagement holes of the wiring substrate. The first side face portion 111b and the second side face portion 111c are portions that abut with the engagement holes of the wiring substrate. A width of the first side face portion 111b and the second side face portion 111c is set to be larger than the diameter of the engagement holes of the wiring substrate. When the substrate holding portions 92a and 92b are engaged with the engagement holes of the wiring substrate, tensile forces are applied to the wiring substrate. These forces pull in opposing directions from a center portion (center) toward both end portions (lateral direction), which is to say outward in the x-direction.

As illustrated in FIG. 18, the connection element 93 includes a connection terminal 120, a first end portion 121, a second end portion 122, a first portion 123, a second portion 124, and the central portion 125. The connection terminal 120, the first end portion 121, the

second end portion 122, the first portion 123, the second portion 124, and the central portion 125 are integrally formed and located in the same plane.

The connection terminal 120 is a portion at one end of the connection element 93 and is configured to have a linear shape. The connection terminal 120 electrically contacts a contact portion (not shown in the drawings) provided on the circuit board. A part of the connection terminal 120 is embedded in the first sidewall portion 95 and at the same time an end portion of the connection terminal 120 is positioned outward of the external face of the first sidewall portion 95.

A part of the first end portion 121 is embedded in the third sidewall portion 97, and supported by and fixed to the third sidewall portion 97. The first end portion 121 is configured to have a linear shape, and extends generally parallel to the connection terminal 120 at a higher position than the connection terminal 120. A part of the second end portion 122 is embedded in the first sidewall portion 95, and supported by and fixed to the first sidewall portion 95. Thus, the connection elements 93 are fixed to and supported by the housing 91 at the two locations of the second end portion 122 and the first end portion 121.

The first portion 123 is a portion between the first end portion 121 and the central portion 125. The first portion 123 is provided contiguous to the first end portion 121 and extends with an incline from the third sidewall portion 97 toward the first sidewall portion 95 side, the incline facing toward the open surface OS side. The second portion 124 is a portion between the second end portion 122 and the central portion 125. The second portion 124 includes a first linear part (linear portion) 124a, a second linear part 124b, a third linear part 124c, a first bent part (bent portion) 124d and a second bent part 124e.

The first linear part 124a and the second linear part 124b are joined by the first bent part 124d that is generally V-shaped. The first linear part 124a extends toward the third sidewall portion 97 side from the second end portion 122, and has a downward incline from

the first sidewall portion 95 side to the third sidewall portion 97 side. The second linear part 124b extends from the first bent part 124d toward the third sidewall portion 97 side, and has an upward incline from the first sidewall portion 95 side to the third sidewall portion 95 side.

The second linear part 124b and the third linear part 124c are joined by the second bent part 124e that is generally V-shaped. The third linear part 124c extends from the second bent part 124e toward the first sidewall portion 95 side, and has an upward incline from the third sidewall portion 97 side toward the first sidewall portion 95 side. In other words, the third linear part 124c is bent back on the second linear part 124b by way of the second bent part 124e.

The central portion 125 includes a bent portion 125a with a U-shaped bend and joins the first portion 123 and the second portion 124 in such a way that the first portion 123 and the third linear part 124c of the second portion 124 are generally parallel with a predetermined gap therebetween. A top part of the central portion 125 is a contact point with a terminal of the wiring substrate. The central portion 125 is inclined with respect to the top faces 95a to 97a of the first through third sidewall portions 95 to 97, which is to say the open surface OS, and protrudes higher than (outward of) the open surface OS. As a result, the connection element 93 enables contact with the terminal of the wiring substrate that is mounted from above.

Note that the connection element 93 adjacent to the connection element 93 described above has a configuration equivalent to the above configuration but flipped from right to left. Specifically, in the connection element 93 adjacent to the connection element 93 described above, the connection terminal 120 is located outward of the second sidewall portion 96 and the first end portion 121 is fixed to the third sidewall portion 97. The second end portion 122 is fixed to the second sidewall portion 96.With such a configuration, the contact points of the connection elements 93 are arranged in staggered form.

As described above, in the housing 91 of the electrical connector 90, the open surface OS is demarcated by the first sidewall portion 95, the second sidewall portion 96, and the third sidewall portion 97. Further, the connection elements 93 are arranged in rows between the first sidewall portion 95 and the third sidewall portion 97 and between the second sidewall portion 96 and the third sidewall portion 97 while at the same time being fixed by the first sidewall portion 95 and the third sidewall portion 97 and by the second sidewall portion 96 and the third sidewall portion 97. The central portion 125 (contact point with the wiring substrate) of each connection element 93 protrudes outward and is exposed at the open surface OS.

In an electrical connector 90 of this construction, the connection elements 93 project from the open surface OS. A connection between the connection elements 93 and the terminals of the wiring substrate can therefore be made by mounting the wiring substrate on the electrical connector 90. Hence, when the wiring substrate is attached to the electrical connector 90, the wiring substrate is mounted on the electrical connector 90 from above the electrical connector 90 and then pressed from above the wiring substrate. In other words, with the electrical connector 90 of the present embodiment, the wiring substrate can be mounted on the electrical connector 90 by pressing in from above.

[Fourth Embodiment]

Next, the fourth embodiment will be described. FIG. 19 is a perspective view of an electrical connector of the circuit assembly according to the third embodiment. FIG. 20 is a sectional view through B-B in FIG. 19.

As illustrated in FIG. 19 and FIG. 20, an electrical connector 130 includes a housing 131, substrate holding portions 92a and 92b, and connection elements 132. The

substrate holding portions 92a and 92b have a similar construction to the substrate holding portion in the electrical connector 90.

The housing 131 illustrated in FIG. 19 includes connection element holding portions 134 in which the connection elements 132 are arranged. The connection element holding portions 134 are formed in the same number as the connection elements 132 (40 in this case) and are provided in correspondence with the rows of the connection elements 132. Specifically, the connection element holding portions 134 are provided on both width-direction sides of the housing 131 and are arranged in staggered form. A top face of the housing 131 is flat and forms an open surface OS.

As illustrated in FIG. 20, the connection elements 132 in the connection element holding portions 134 are held with one or both end portions held by the housing 131. The connection element 132 includes a connection terminal 140, a first end portion 141, a second end portion 142, a first portion 143, a second portion 144, and a central portion 145. The connection terminal 140, the first end portion 141, the second end portion 142, the first portion 143, the second portion 144, and the central portion 145 are integrally formed and located in the same plane. The connection elements 132 in the housing 131 are press fitted into the connection element holding portions 134.

The connection terminal 140 is a portion at one end of the connection elements 132 and is configured to have a linear shape. The connection terminal 140 electrically contacts a contact portion (not shown in the drawings) provided on the circuit board. The connection terminal 140 is located on the outward side of the external face of the housing 131.

A part of the first end portion 141 is press fitted in the housing 131, and supported by and fixed to the housing 131. The second end portion 142 is generally U-shaped and is supported by and fixed to the housing 131. Thus, the connection elements 132 are fixed to

and supported by the housing 131 at the two locations of the second end portion 142 and the first end portion 141.

The first portion 143 is a portion between the first end portion 141 and the central portion 145. The first portion 143 is provided contiguous to the first end portion 141 and extends with an incline toward the open surface OS side. The second portion 144 is a portion between the second end portion 142 and the central portion 145. The second portion 144 includes a first linear part (linear portion) 144a, a second linear part 144b, a third linear part 144c, a first bent part (bent portion) 144d, and a second bent part 144e.

The first linear part 144a and the second linear part 144b are joined by the first bent part 144d that is generally V-shaped. The first linear part 144a extends toward the first end portion 141 side from the second end portion 142, and has a downward incline from the second end portion 142 toward the first end portion 141 side. The second linear part 144b extends from the first bent part 144d toward the first end portion 141 side, and has an upward incline from the second end portion 142 side toward the first end portion 141 side.

The second linear part 144b and the third linear part 144c are joined by the second bent part 144e that is generally V-shaped. The third linear part 144c extends from the second bent part 144e toward the second end portion 142 side, and has an upward incline from the first end portion 141 side toward the second end portion 142 side. In other words, the third linear part 144c is bent back on the second linear part 144b by way of the second bent part 144e.

The central portion 145 includes a bent portion 145a with a U-shaped bend and joins the first portion 143 and the second portion 144 in such a way that the first portion 143 and the third linear part 144c of the second portion 44 are generally parallel with a predetermined gap therebetween. A top part of the central portion 145 is a contact point with a terminal of the wiring substrate. The central portion 145 is inclined with respect to the open

surface OS and protrudes higher than (outward of) the open surface OS. As a result, the connection element 132 enables contact with the terminal of the wiring substrate that is mounted from above.

As described above, the housing 131 of the electrical connector 130 includes the open surface OS. Further, the connection elements 132 are held by the connection element holding portions 134 of the housing 131 and the central portion 145 (contact point with the wiring substrate) of each connection element 132 protrudes outward and is exposed at the open surface OS.

In an electrical connector 130 of this construction, the connection elements 132 project from the open surface OS. A connection between the connection elements 132 and the terminals of the wiring substrate can therefore be made by mounting the wiring substrate on the electrical connector 130. Hence, when the wiring substrate is attached to the electrical connector 130, the wiring substrate is placed on the electrical connector 130 from above the electrical connector 130 and then pressed from above the wiring substrate. In other words, with the electrical connector 130 of the present embodiment, the wiring substrate can be mounted on the electrical connector 130 by pressing in from above.

1 and 50 Circuit assembly; 2 and 51 wiring substrate (wiring substrate); 3, 52, 90, and 130 electrical connector; 7 engagement opening (fixture receiving means); 10, 60, 91, and 131 housing; 12a, 12b, 92a, and 92b wiring holding portion (fixture means); 14, 93, and 132 connection element; 20, 63, and 95 first sidewall portion; 21, 64, and 96 second sidewall portion; 30 base portion; 31 engagement portion; 41 first end portion; 42 second end portion; 43 first portion, 44 second portion; 44a to 44c first through third linear parts (linear portion); 44d and 44e first and second bent parts (bent portion); 134 connection element holding portion; OS open surface.

Item 1 is a circuit assembly comprising: a wiring substrate having fixture receiving means at both end portions; and an electrical connector including a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with the fixture receiving means of the wiring substrate; the fixture means engaging with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are coupled.

Item 2 is the circuit assembly according to item 1, wherein, when the fixture means are engaged with the fixture receiving means, opposing forces acting in a lateral direction from a center of the wiring substrate are applied to the wiring substrate.

Item 3 is the circuit assembly according to item 1, further comprising a pressing member arranged on the wiring substrate, the pressing member pressing the wiring substrate toward the housing side.

Item 4 is the circuit assembly according to item 1, further comprising a pressing member arranged on the wiring substrate, the pressing member pressing the wiring substrate toward the housing side, wherein, when the fixture means are enaged with the fixture receiving means, opposing forces acting in a lateral direction from a center of the wiring substrate are applied to the wiring substrate.

Item 5 is the circuit assembly according to any one of items 1 to 4, wherein the housing includes at least a first sidewall portion and a second sidewall portion arranged so as to oppose each other, with the open surface being demarcated by this first sidewall portion and this second sidewall portion, and wherein the connection elements are arranged in a predetermined position between the first sidewall portion and the second sidewall portion, while being held by one or both of the first sidewall portion and the second sidewall portion.

Item 6 is the circuit assembly according to any one of items 1 to 4, wherein the housing comprises a connection element holding portion in which the connection elements are arranged, and the connection elements are held at one end portion or both end portions in the connection element holding portion.

Item 7 is the circuit assembly according to item 6, wherein the connection element comprises: a first end portion that is embedded in a predetermined position in the first sidewall portion; a second end portion that is embedded in a predetermined position of the second sidewall portion; a first portion that is contiguous on the first end portion side and extends to the second sidewall portion side; a second portion that is contiguous on the second end portion side and extends to the first sidewall portion side, and a central portion that connects the first portion and the second portion with a bent part, and wherein the second portion includes a plurality of linear portions and a plurality of bent portions, one linear portion of the plurality of linear portions and the first portion are generally parallel and are inclined with respect to the open surface, and the central portion moves elastically toward the open surface when the electrical connector is coupled to the wiring substrate.

Item 8 is the circuit assembly according to any one of items 1 to 7, wherein the fixture receiving means include holes formed at both end portions of the wiring substrate, and the fixture means include an engagement portion configured to allow engagement with the holes of the wiring substrate and a base portion that is contiguous with the engagement portion and fixed to the housing.

Item 9 is an assembly method for a circuit assembly including a wiring substrate and an electrical connector, the wiring substrate having fixture receiving means at both end portions, the electrical connector including a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held by the housing and protruding so that central portions thereof incline outward from the open surface, and, at both

ends of the housing, fixture means provided to correspond with the fixture receiving means of the wiring substrate, the method comprising a step of mounting the housing of the electrical connector on the wiring substrate and engaging the fixture means with the fixture receiving means of the wiring substrate.

Item 10 is an electrical connector for coupling with a wiring substrate, the electrical connector comprising: a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with fixture receiving means of the wiring substrate, wherein the fixture means engage with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are coupled.

Item 11 is the electrical connector according to item 10, wherein, when the fixture means are engaged with the fixture receiving means, opposing forces acting in a lateral direction from a center of the wiring substrate are applied to the wiring substrate.

Item 12 is the electrical connector according to item 10 or 11, wherein the fixture receiving means include holes formed at both end portions of the wiring substrate, and the fixture means include an engagement portion configured to allow engagement with the holes of the wiring substrate and a base portion that is contiguous with the engagement portion and fixed to the housing.

Item 13 is the electrical connector according to any one of items 10 to 12, wherein the housing includes at least a first sidewall portion and a second sidewall portion arranged so as to oppose each other, with the open surface being demarcated by this first sidewall portion and this second sidewall portion, and wherein the connection elements are arranged in a predetermined position between the first sidewall portion and the second sidewall portion, while being held by one or both of the first sidewall portion and the second sidewall portion.

Item 14 is the electrical connector according to item 13, wherein the connection element comprises: a first end portion that is embedded in a predetermined position in the first sidewall portion; a second end portion that is embedded in a predetermined position of the second sidewall portion; a first portion that is contiguous on the first end portion side and extends to the second sidewall portion side; a second portion that is contiguous on the second end portion side and extends to the first sidewall portion side, and a central portion that connects the first portion and the second portion with a bent part, and wherein the second portion includes a plurality of linear portions and a plurality of bent portions, one linear portion of the plurality of linear portions and the first portion are generally parallel and are inclined with respect to the open surface, and the central portion moves elastically toward the open surface when the electrical connector is coupled to the wiring substrate.

What is Claimed is:

1. A circuit assembly comprising: a wiring substrate having fixture receiving means at both end portions; and an electrical connector including a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with the fixture receiving means of the wiring substrate; the fixture means engaging with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are coupled.

2. The circuit assembly according to claim 1, wherein, when the fixture means are engaged with the fixture receiving means, opposing forces acting in a lateral direction from a center of the wiring substrate are applied to the wiring substrate.

3. The circuit assembly according to claim 1, further comprising a pressing member arranged on the wiring substrate, the pressing member pressing the wiring substrate toward the housing side.

4. The circuit assembly according to claim 1, further comprising a pressing member arranged on the wiring substrate, the pressing member pressing the wiring substrate toward the housing side, wherein, when the fixture means are enaged with the fixture receiving means, opposing forces acting in a lateral direction from a center of the wiring substrate are applied to the wiring substrate.

5. The circuit assembly according to any one of claims 1 to 4, wherein the housing includes at least a first sidewall portion and a second sidewall portion arranged so as to oppose each other, with the open surface being demarcated by this first sidewall portion and this second sidewall portion, and wherein the connection elements are arranged in a predetermined position between the first sidewall portion and the second sidewall portion, while being held by one or both of the first sidewall portion and the second sidewall portion.

6. The circuit assembly according to any one of claim 1 to 4, wherein the housing comprises a connection element holding portion in which the connection elements are arranged, and the connection elements are held at one end portion or both end portions in the connection element holding portion.

7. The circuit assembly according to claim 6, wherein the connection element comprises: a first end portion that is embedded in a predetermined position in the first sidewall portion; a second end portion that is embedded in a predetermined position of the second sidewall portion; a first portion that is contiguous on the first end portion side and extends to the second sidewall portion side; a second portion that is contiguous on the second end portion side and extends to the first sidewall portion side, and a central portion that connects the first portion and the second portion with a bent part, and wherein the second portion includes a plurality of linear portions and a plurality of bent portions, one linear portion of the plurality of linear portions and the first portion are generally parallel and are inclined with respect to the open surface, and the central portion moves elastically toward the open surface when the electrical connector is coupled to the wiring substrate.

8. An electrical connector for coupling with a wiring substrate, the electrical connector comprising: a housing having electrical insulation properties and an open surface, a plurality of conductive connection elements held in the housing and protruding so that central portions thereof incline outward from the open surface, and, at both ends of the housing, fixture means provided to correspond with fixture receiving means of the wiring substrate, wherein the fixture means engage with the fixture receiving means of the wiring substrate when the electrical connector and the wiring substrate are coupled.

9. The electrical connector according to claim 8, wherein the housing includes at least a first sidewall portion and a second sidewall portion arranged so as to oppose each other, with the open surface being demarcated by this first sidewall portion and this second sidewall portion, and wherein the connection elements are arranged in a predetermined position between the first sidewall portion and the second sidewall portion, while being held by one or both of the first sidewall portion and the second sidewall portion.

10. The electrical connector according to claim 9, wherein the connection element comprises: a first end portion that is embedded in a predetermined position in the first sidewall portion; a second end portion that is embedded in a predetermined position of the second sidewall portion; a first portion that is contiguous on the first end portion side and extends to the second sidewall portion side; a second portion that is contiguous on the second end portion side and extends to the first sidewall portion side, and a central portion that connects the first portion and the second portion with a bent part, and wherein the second portion includes a plurality of linear portions and a plurality of bent portions, one linear portion of the plurality of linear portions and the first portion are generally parallel and are

inclined with respect to the open surface, and the central portion moves elastically toward the open surface when the electrical connector is coupled to the wiring substrate.

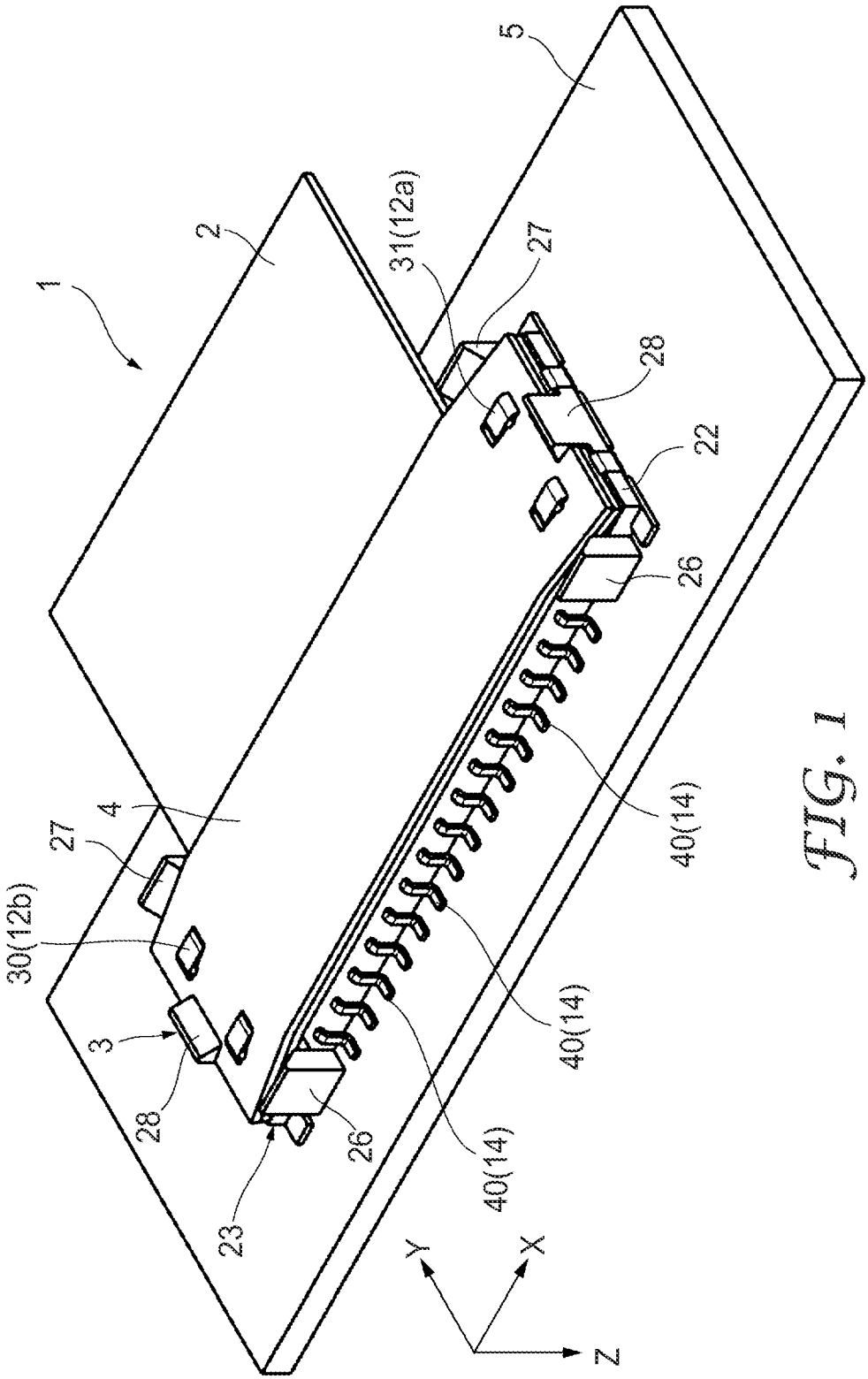
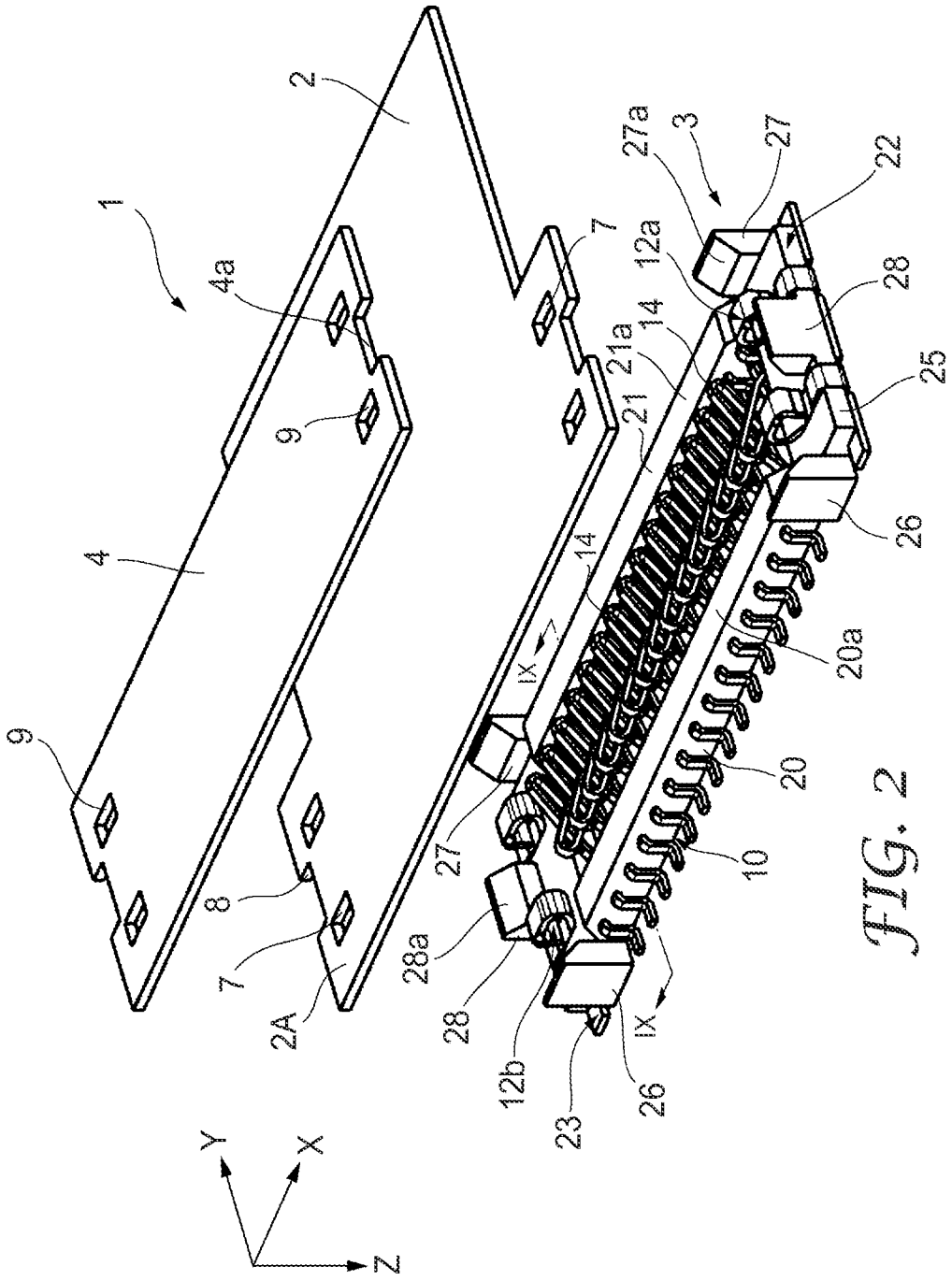



FIG. 1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28a
2A
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IX
Y
X
Z

FIG. 2

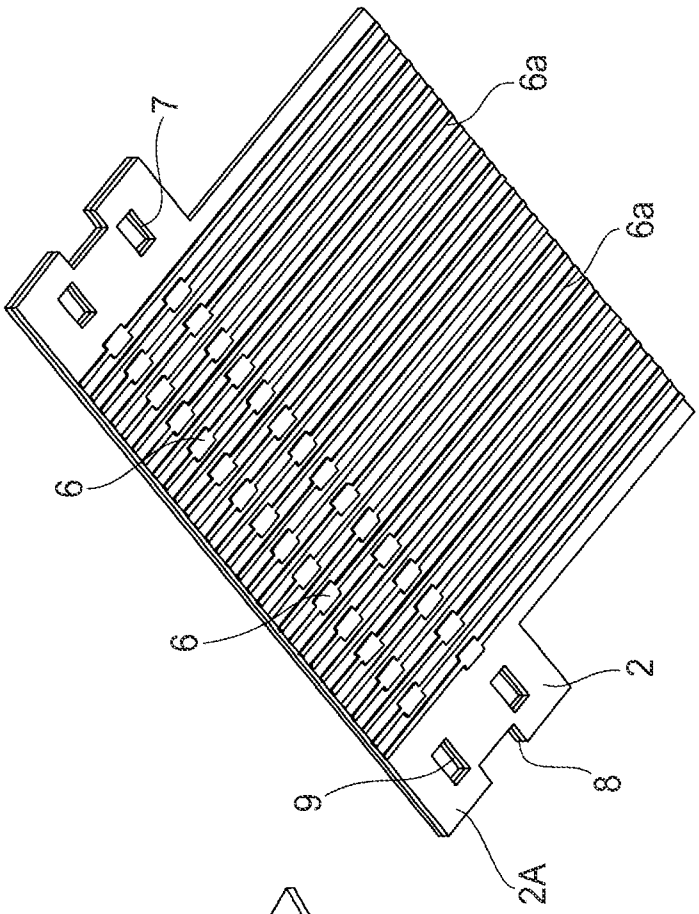


FIG. 3b

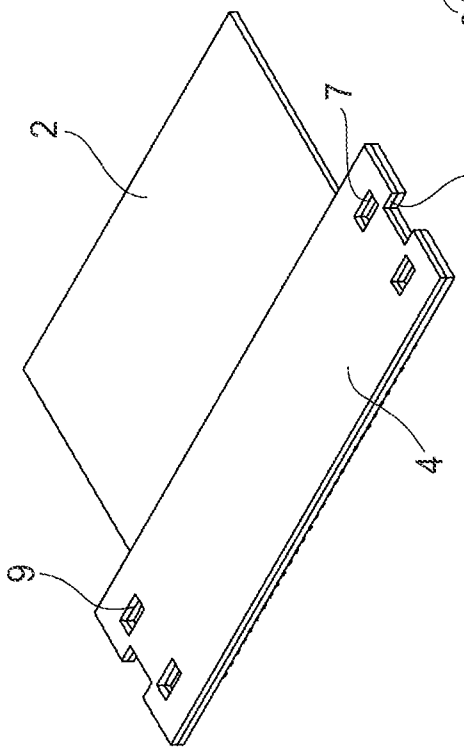


FIG. 3a

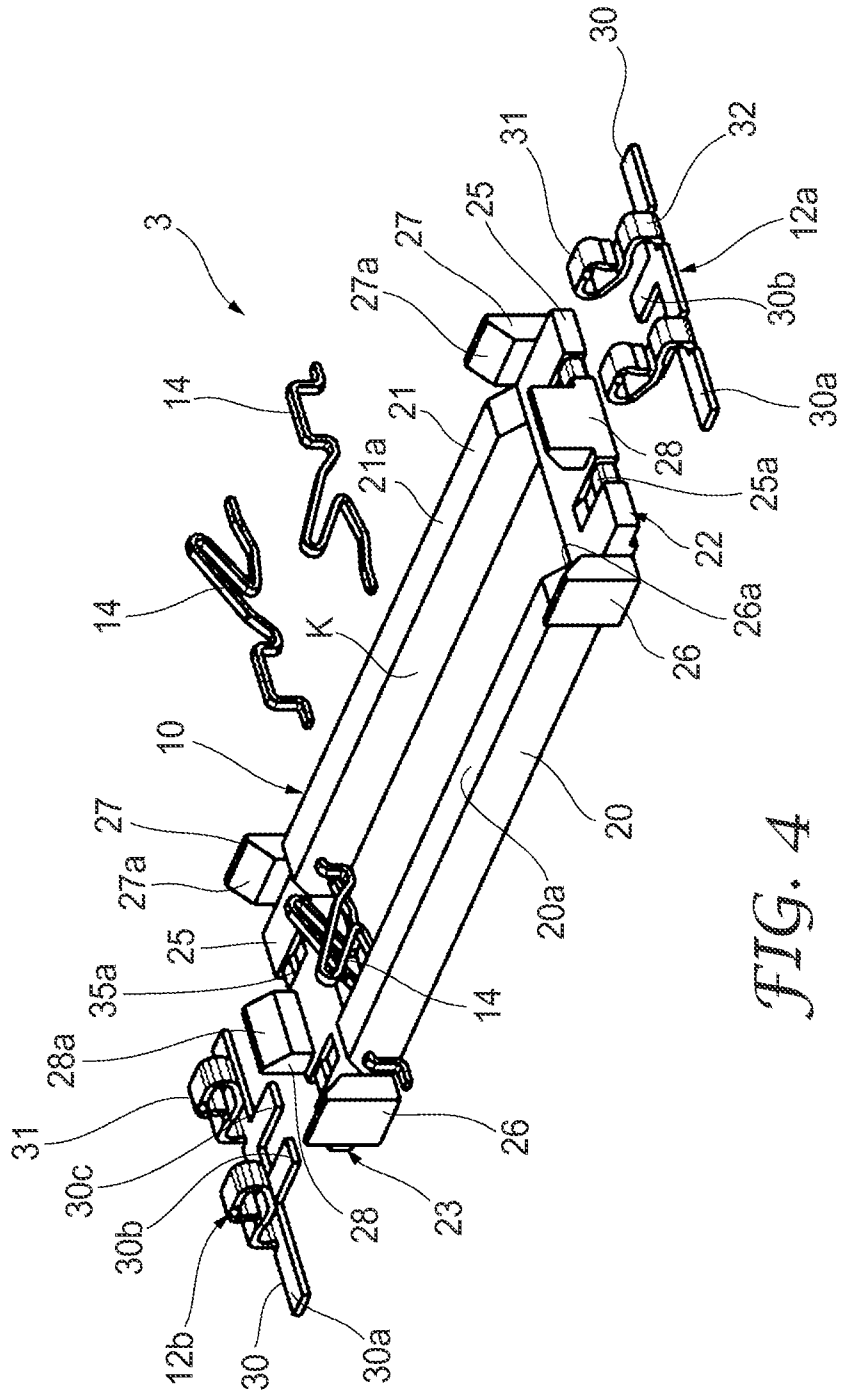
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FIG. 4

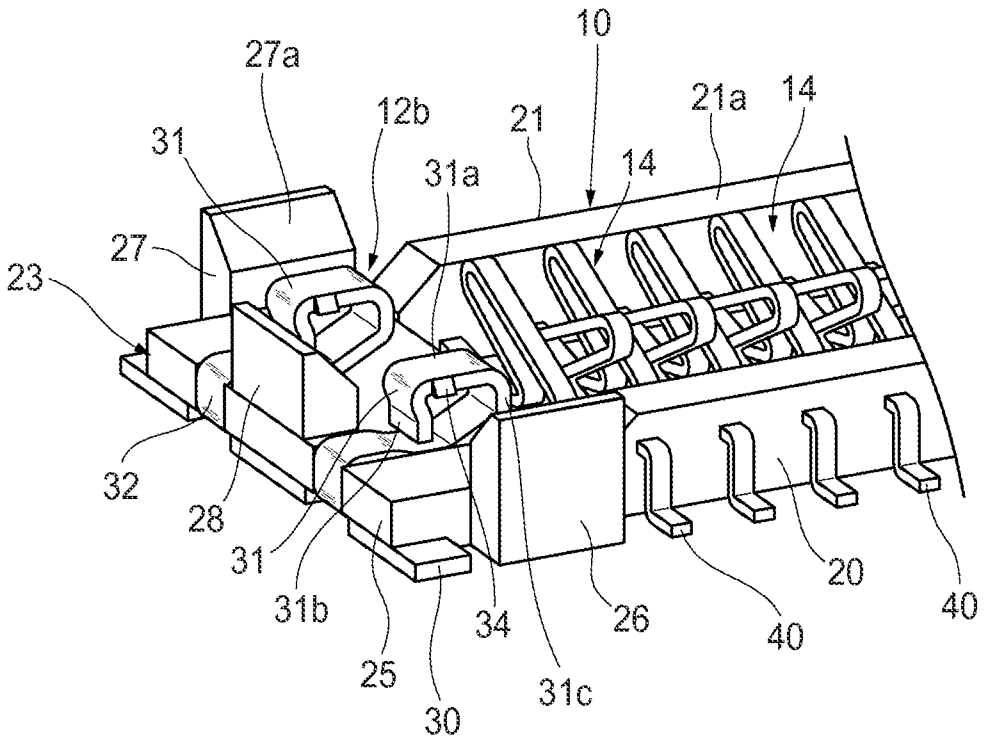
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FIG. 5

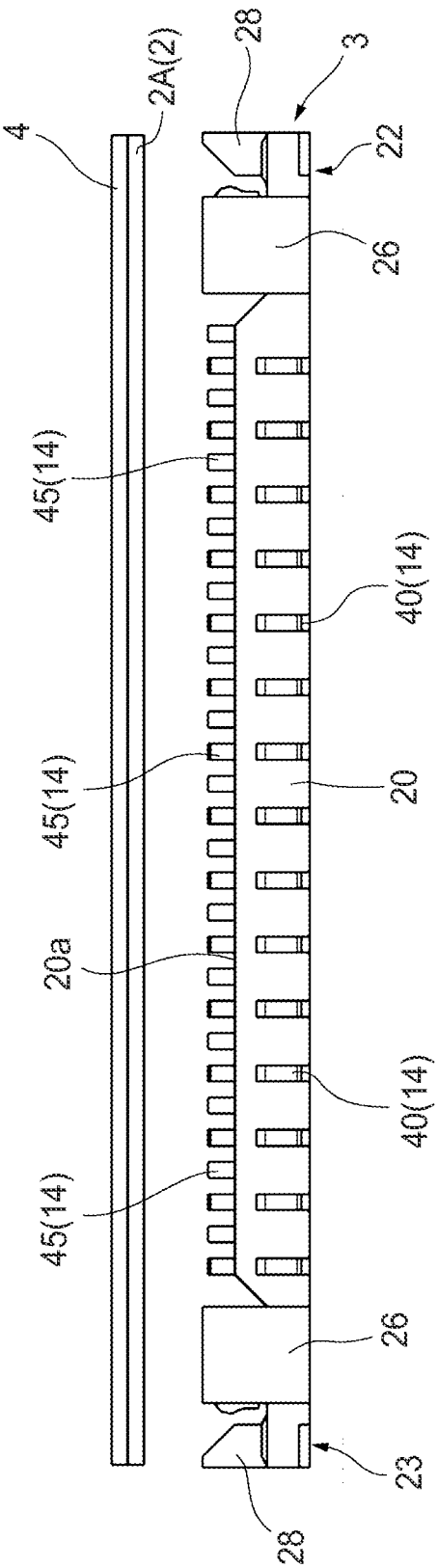
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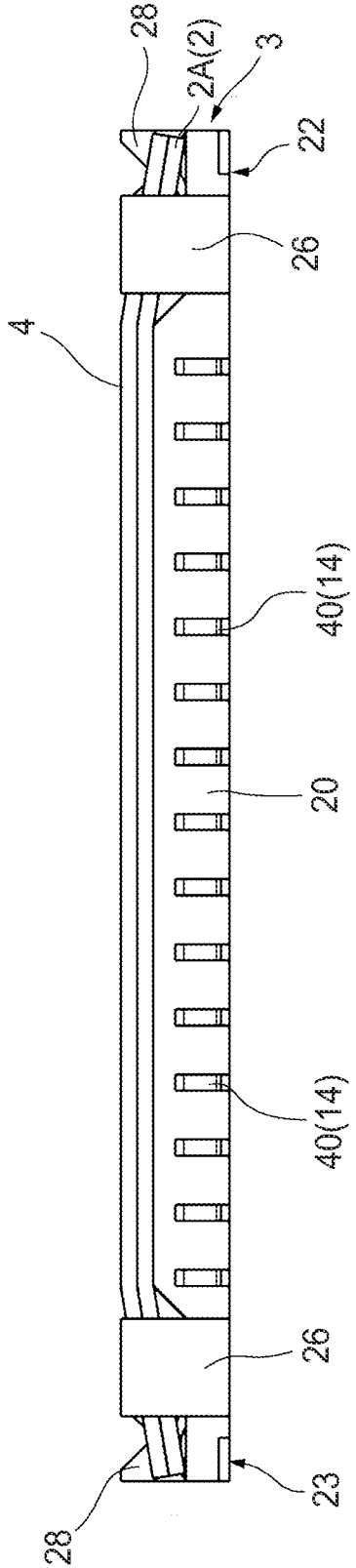
FIG. 6a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40(14)
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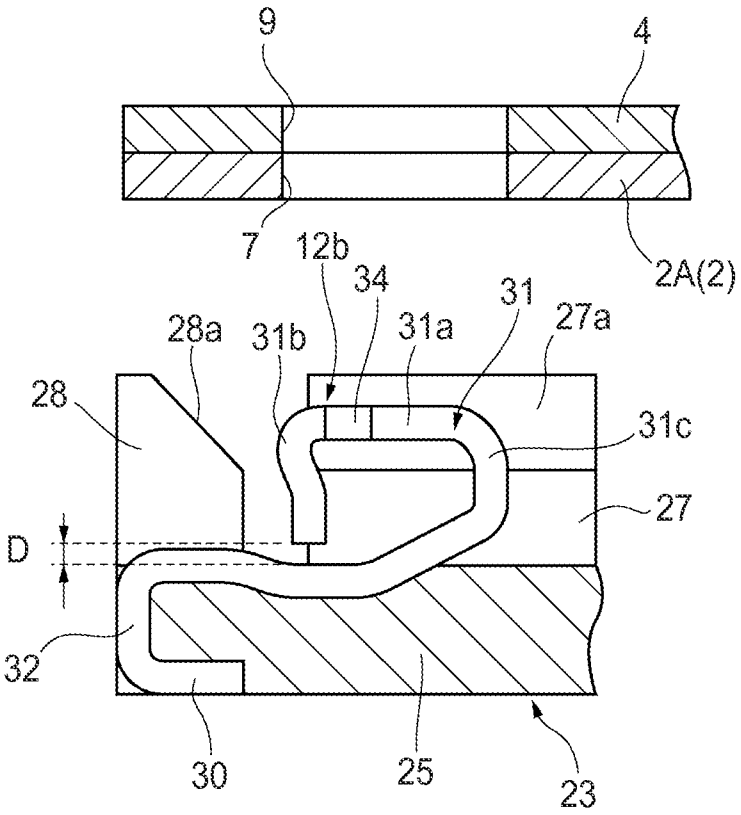
FIG. 6b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23

FIG. 7a

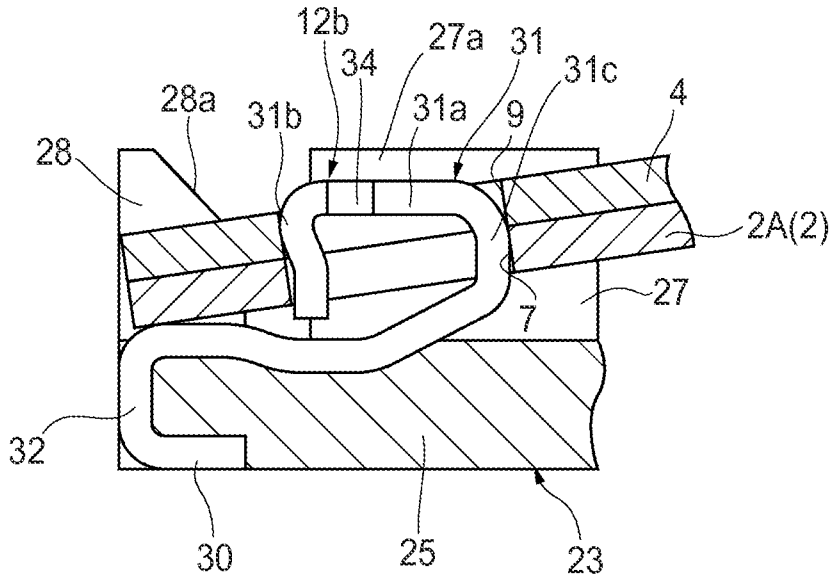
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FIG. 7b

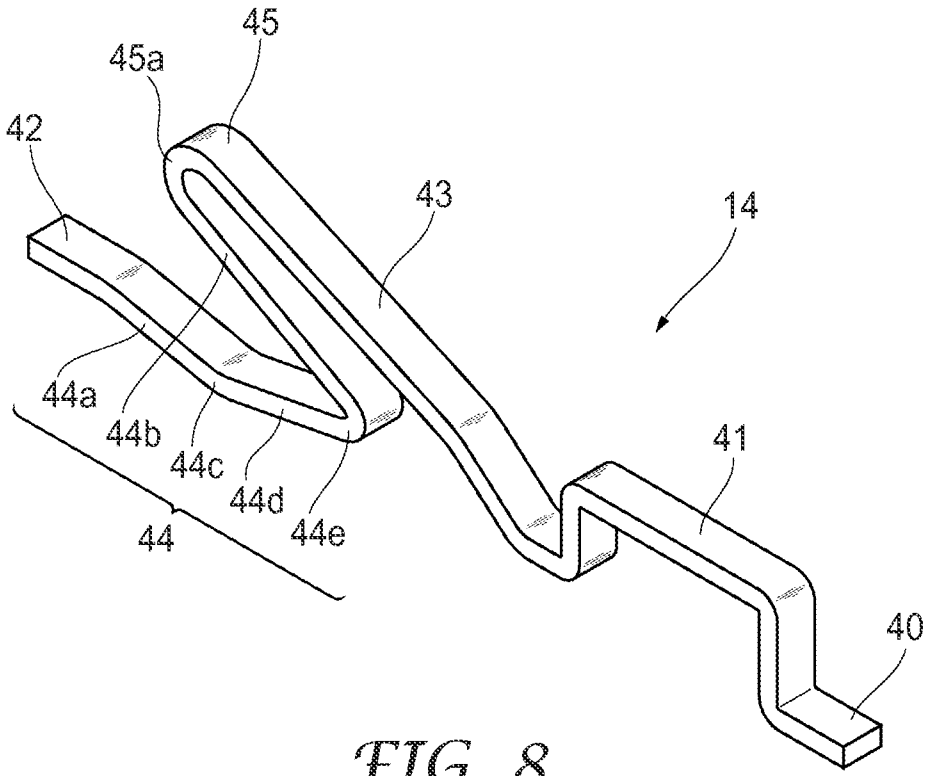
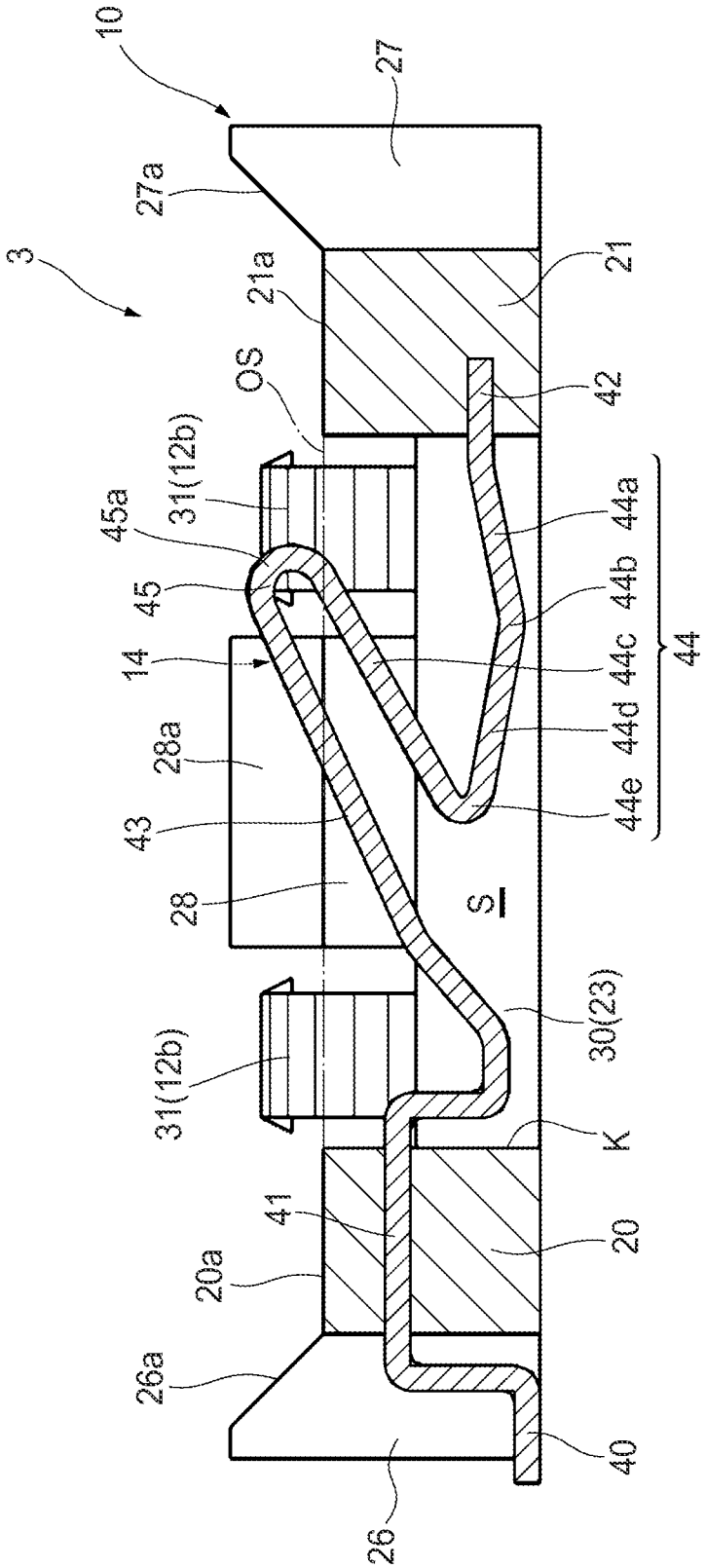



FIG. 8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31(12b)
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FIG. 9

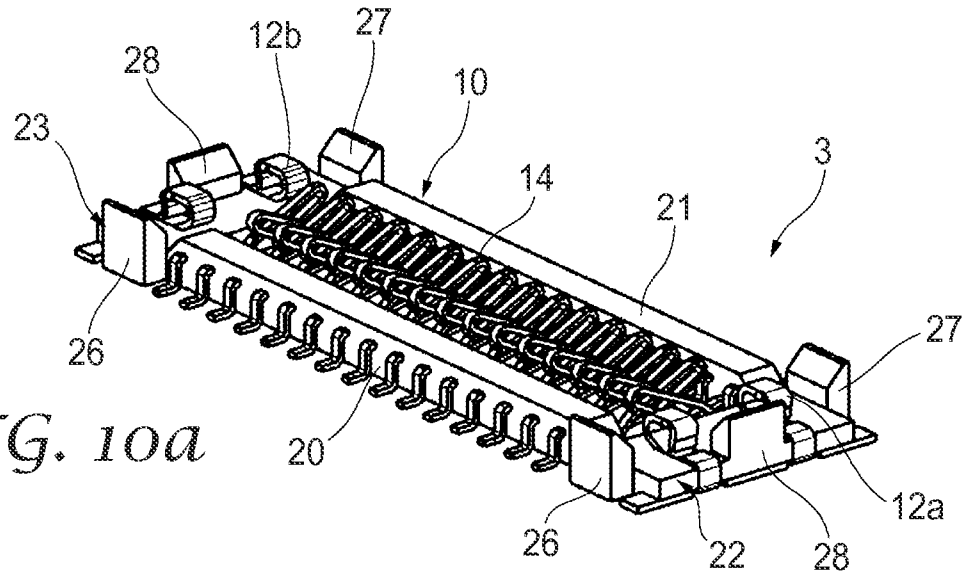


FIG. 10a

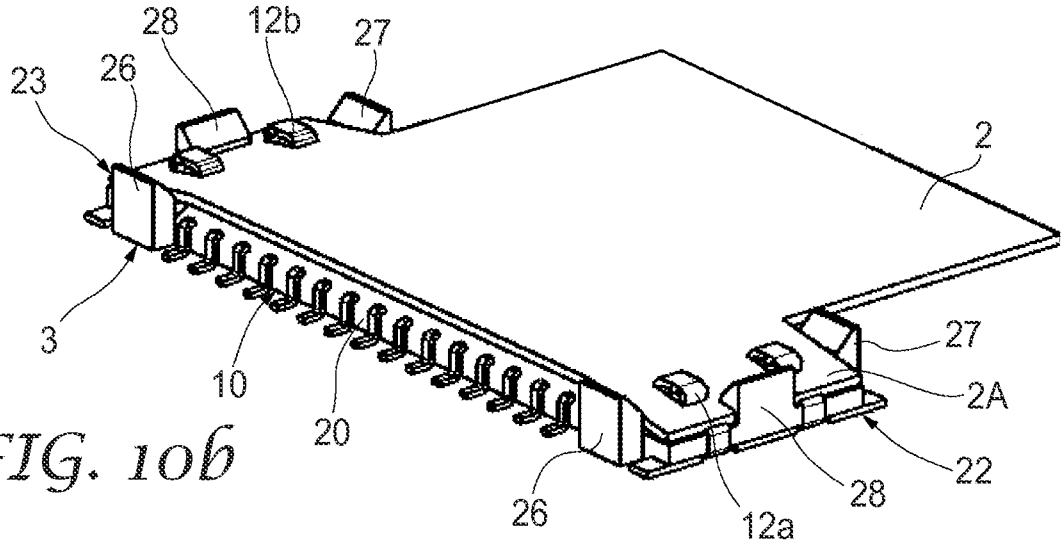


FIG. 10b

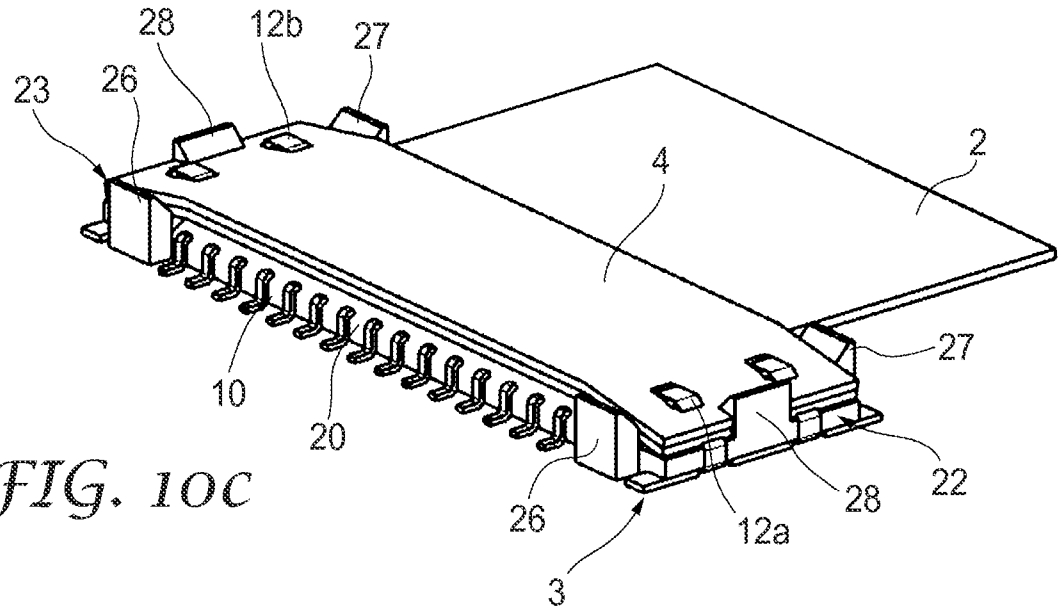


FIG. 10c

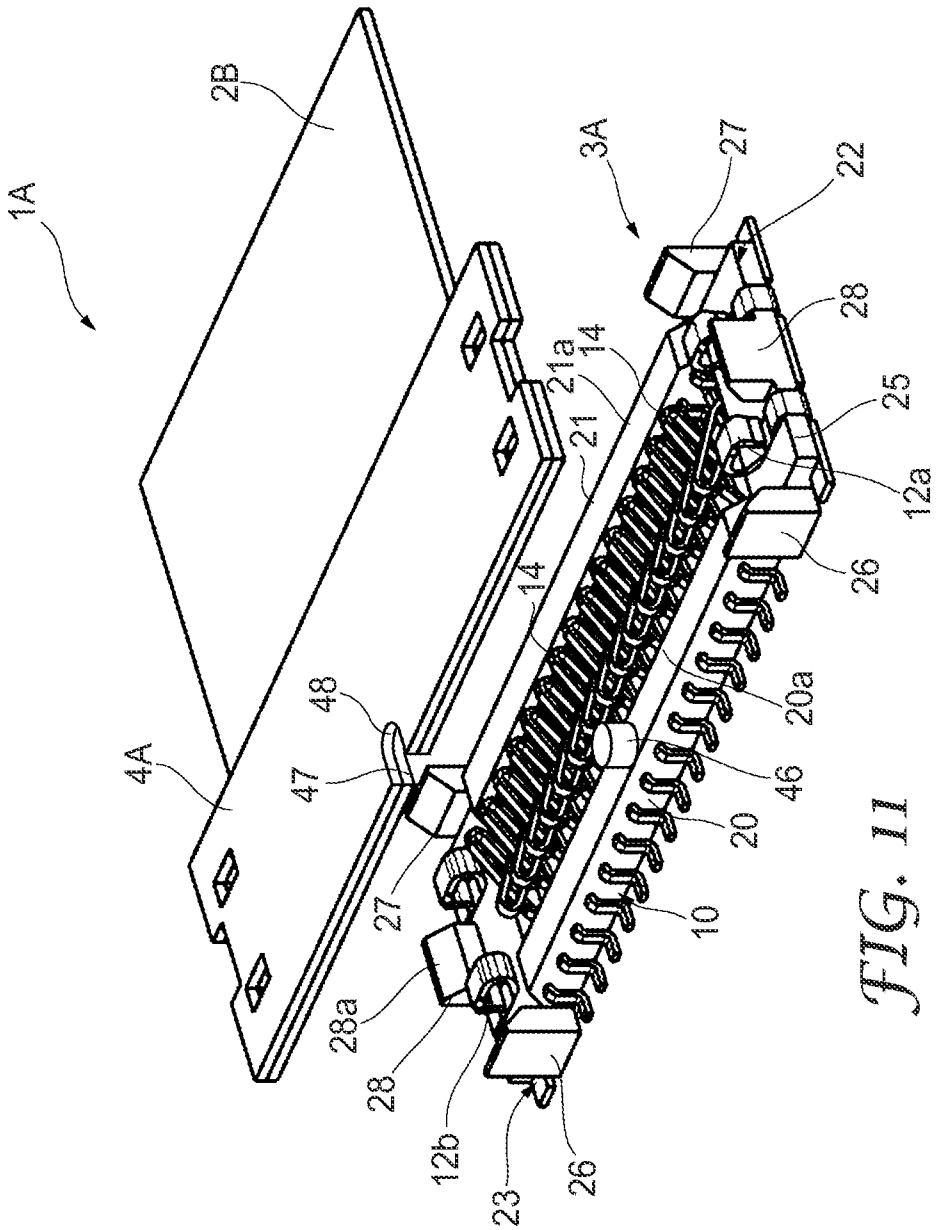
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FIG. 11

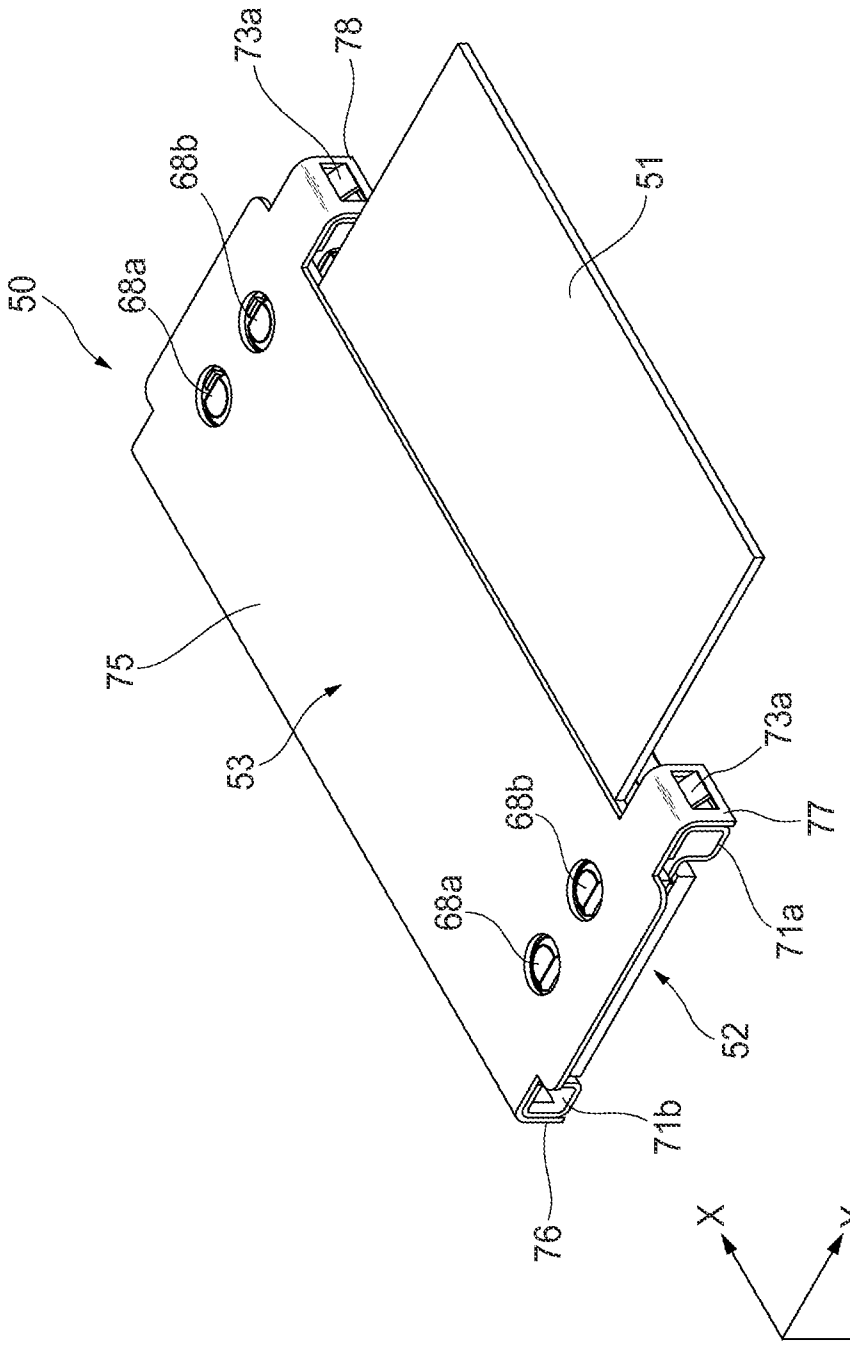


FIG. 12

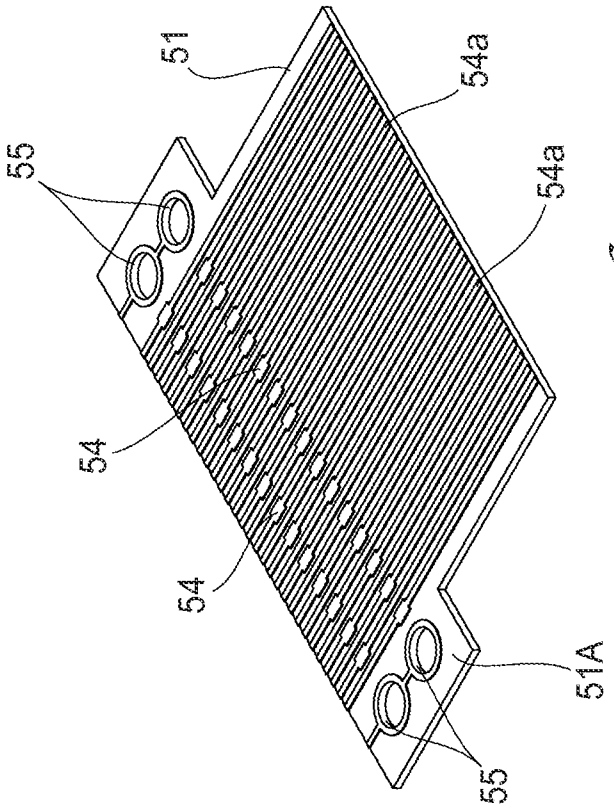


FIG. 13b

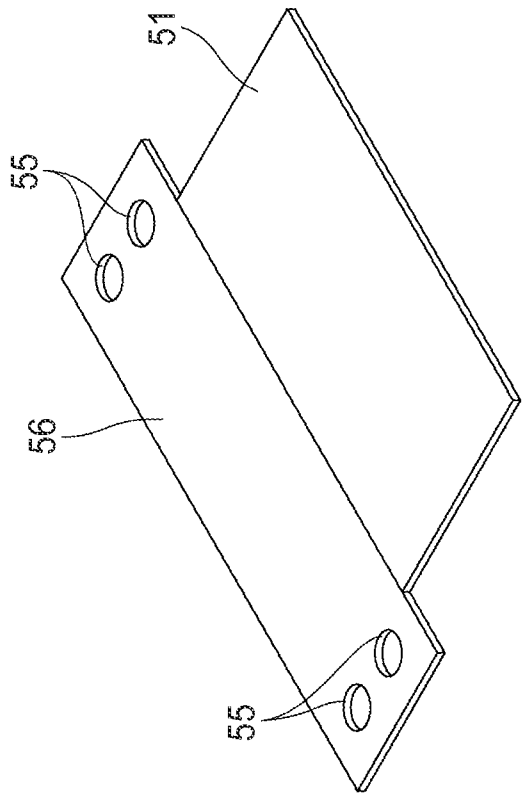


FIG. 13a

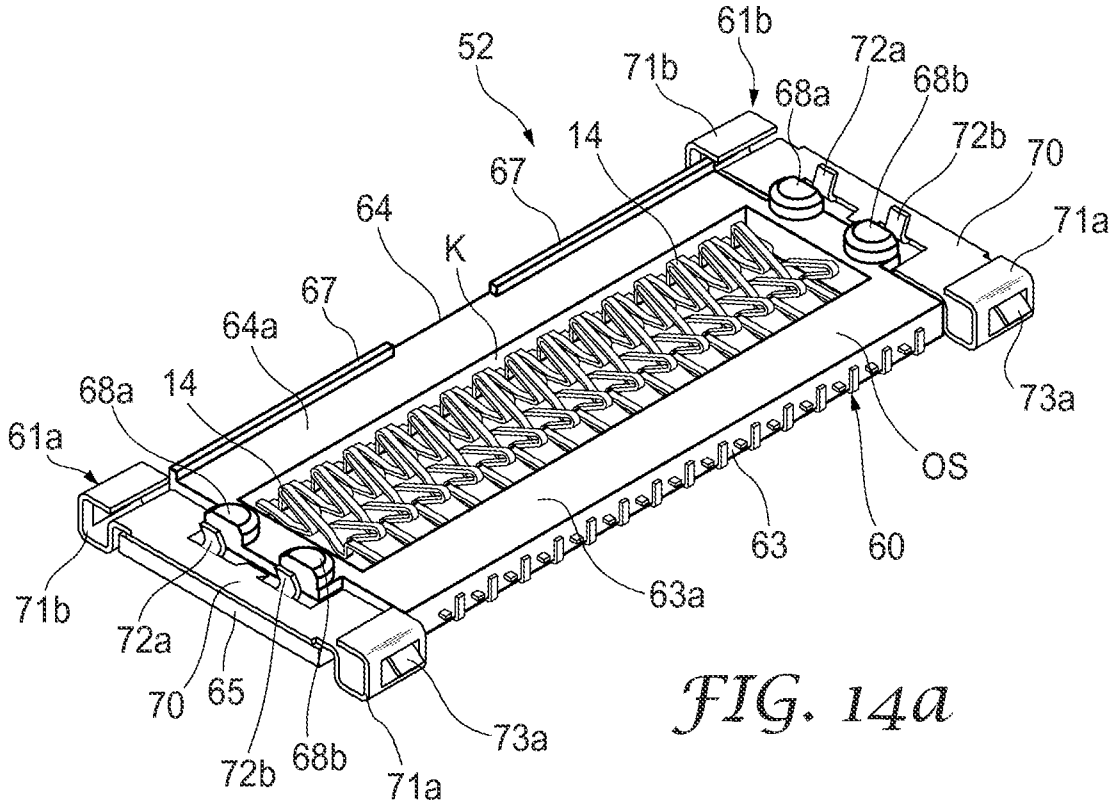


FIG. 14a

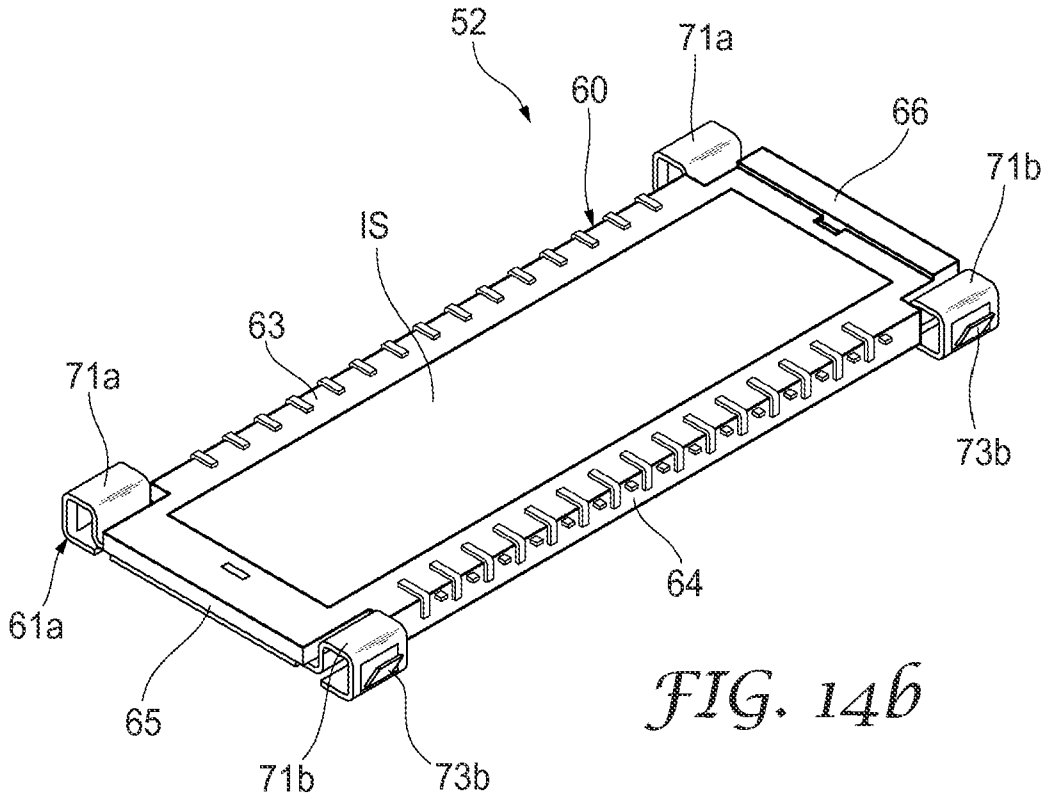


FIG. 14b

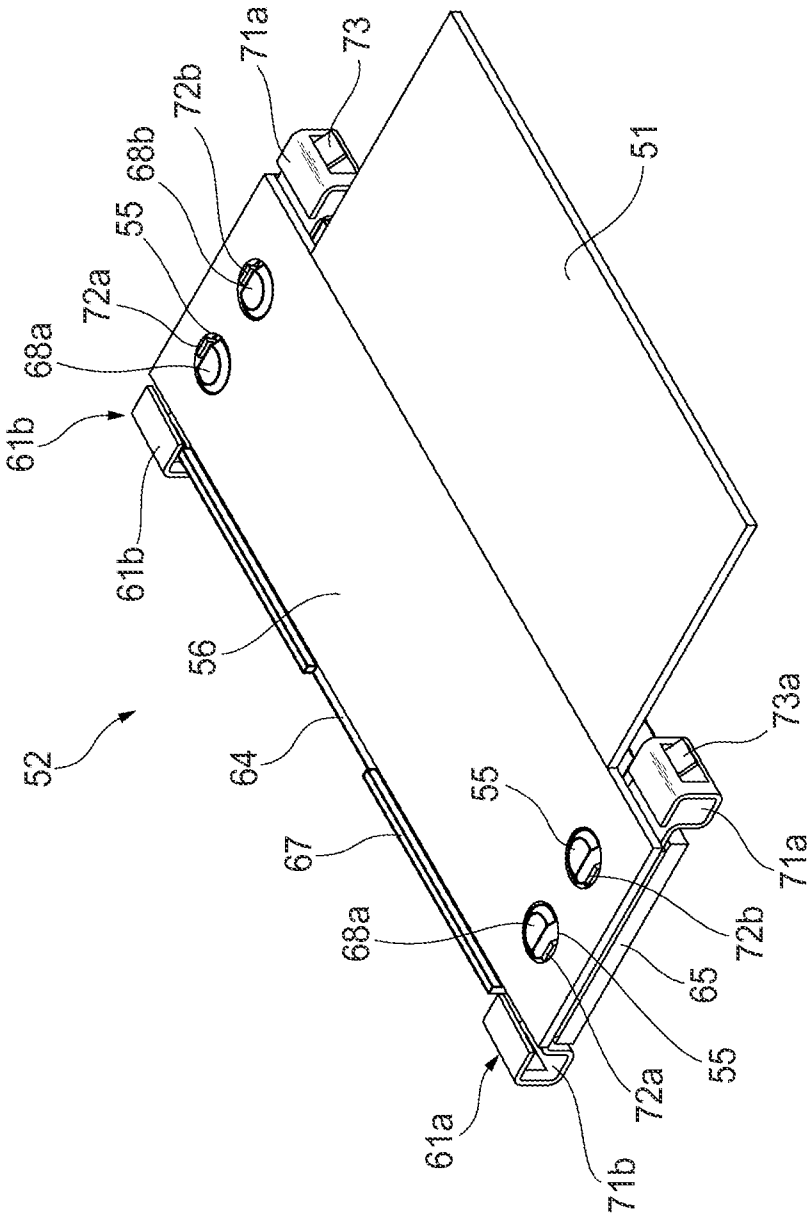
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FIG. 15

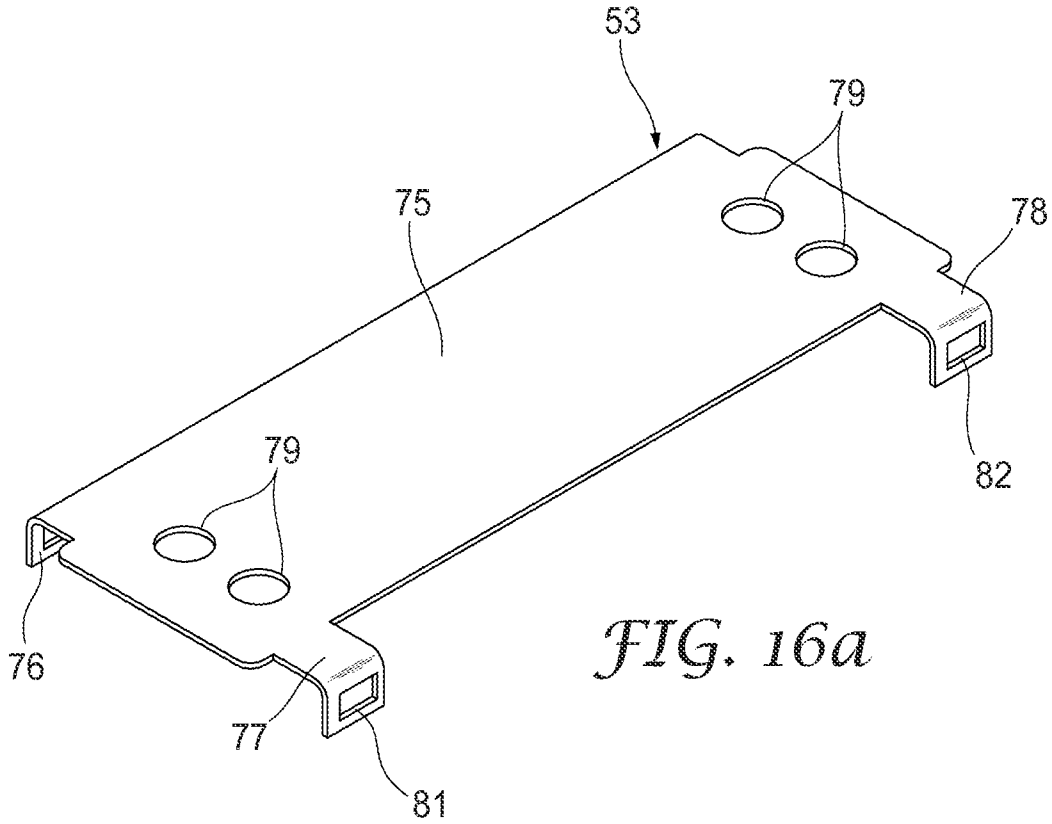


FIG. 16a

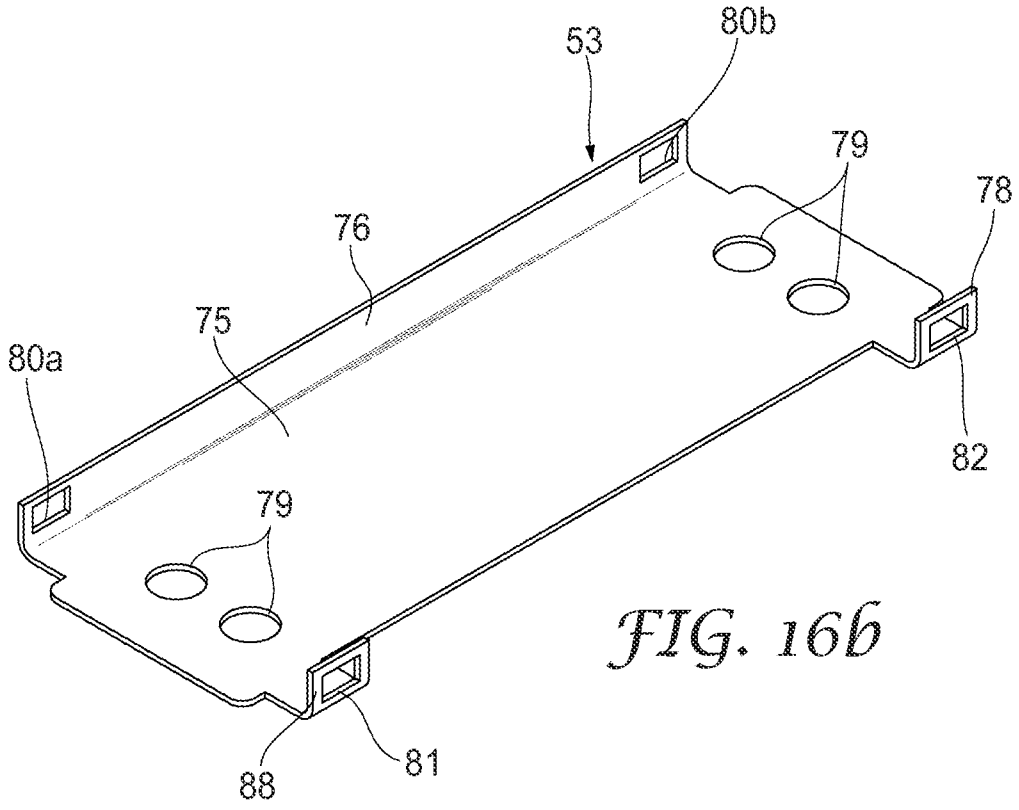


FIG. 16b

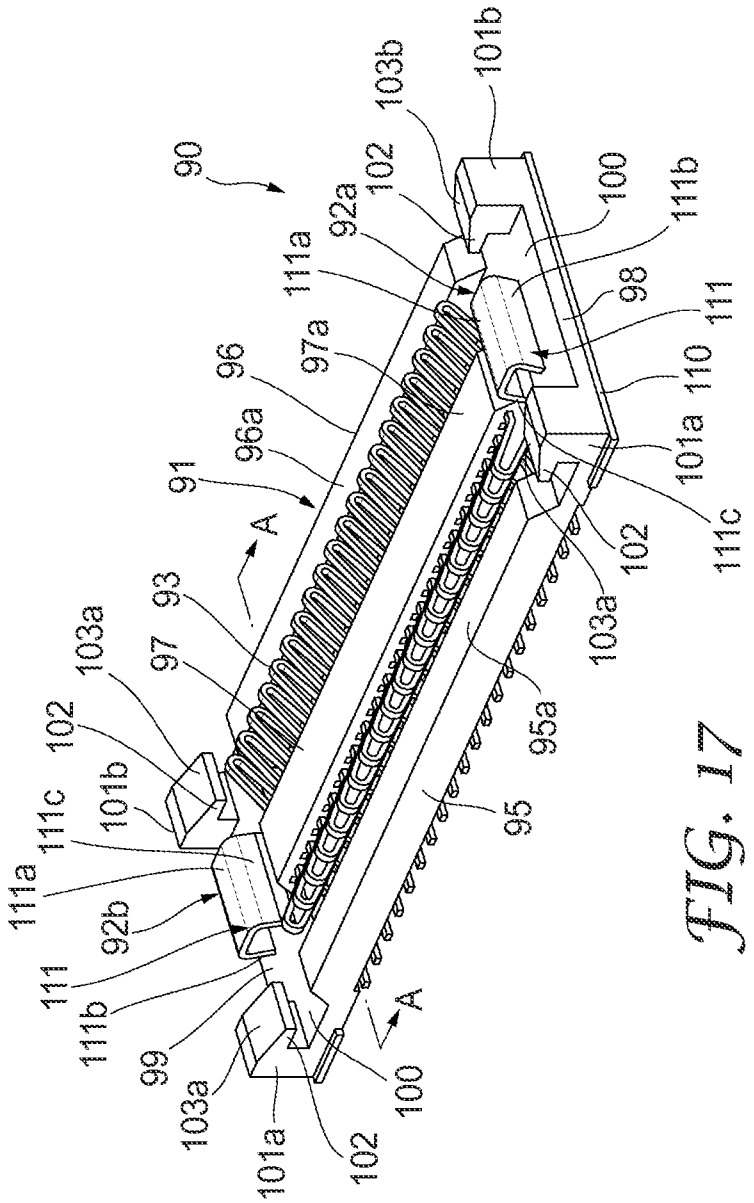
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FIG. 17

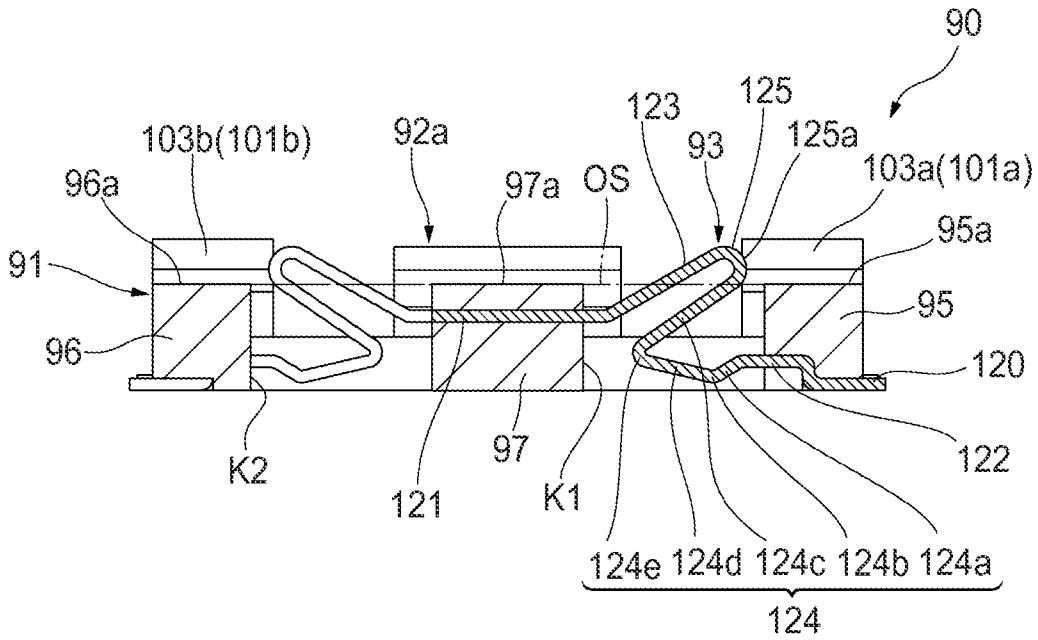
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FIG. 18

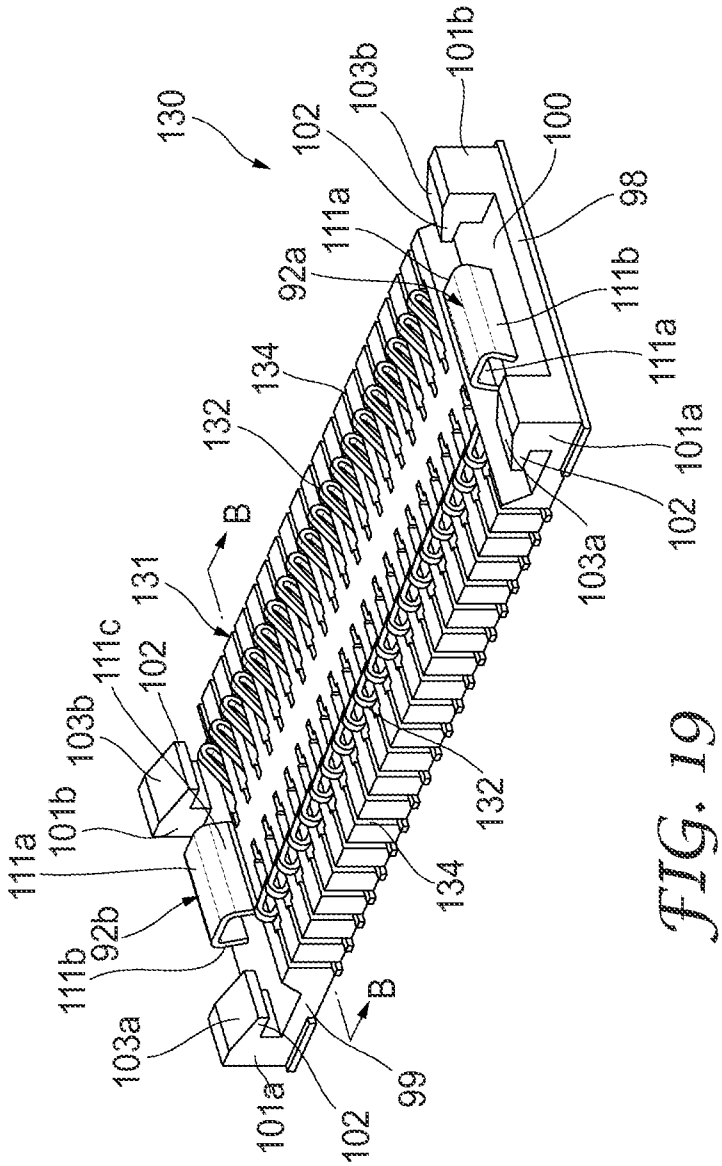
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FIG. 19

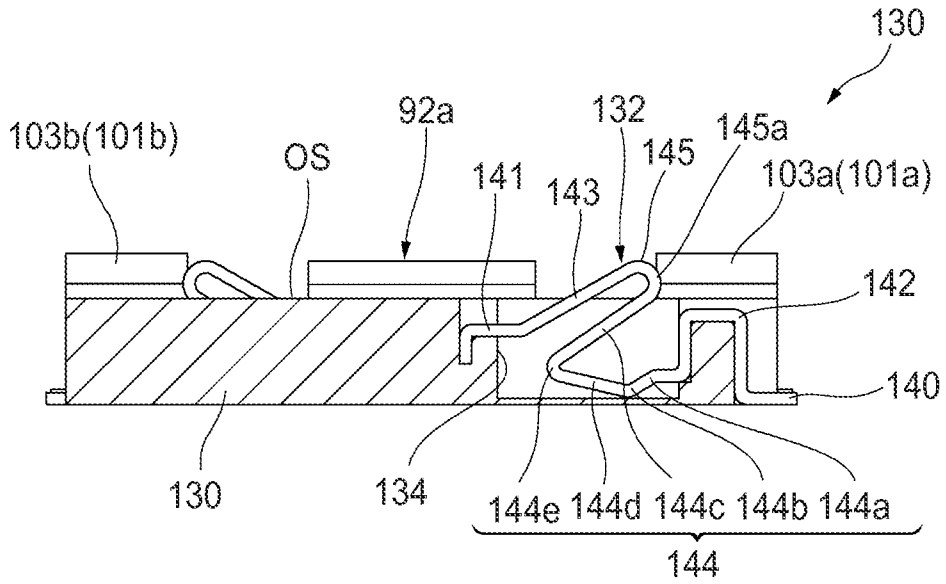
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FIG. 20

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/058854

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R12/77 H01R12/79
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 2 261 558 A (SUMITOMO WIRING SYSTEMS [JP]) 19 May 1993 (1993-05-19) | 1,3,8-10 |
| Y | abstract<br>page 1 - page 9<br>figures 1-3 | 2,4-7 |
| | ----- | |
| X | US 2011/111615 A1 (TSAI TZU-CHING [TW] ET AL) 12 May 2011 (2011-05-12) | 1,3,8-10 |
| Y | the whole document | 2,4-7 |
| | ----- | |
| Y | US 4 172 626 A (OLSSON BILLY E [US]) 30 October 1979 (1979-10-30) | 2,4-7 |
| A | column 3, line 31 - column 3, line 51<br>figure 2 | 1,3,8-10 |
| | ----- | |
| A | US 4 824 379 A (ROBERTS JOSEPH A [US] ET AL) 25 April 1989 (1989-04-25)<br>column 6, line 34 - column 6, line 45 | 1-10 |
| | ----- | |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 11 January 2013 | 18/01/2013 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Pugliese, Sandro |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/058854

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| GB 2261558 A | 19-05-1993 | GB 2261558 A | 19-05-1993 |
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